Can. Murray, Alexander.

P J Sandover-Sly

GEOLOGICAL SURVEY

OF

NEWFOUNDLAND.

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PREFACE.

The constant demand made upon my office at St. John's, Newfoundland, for copies of the 'Reports of Progress on the Geological Survey,' having nearly exhausted the stock placed in my hands for distribution, and many of the earlier numbers being now out of print, I have been induced to re-publish the whole set, in consecutive order, in one volume. The text of each year's Report has been to some extent modified, and they have all been carefully revised and corrected. The subject is divided into twenty chapters, the contents of each chapter being specified in an index and heading, by which means ready reference may be had as to the proceedings of each year, and the descriptions of the various portions of country visited given as examined.

My intention at one time was to condense the history of this investigation into a single work, illustrated by sundry characteristic scenes, a small-scale general geological map and sections, and drawings of typical fossils, explanatory of the views expressed in the text; but the difficulties in the way of preparing such a work, in such form as to do justice to the subject, are so great, that many months, perhaps years, might elapse before it could be completed; and I have consequently resorted to the only ready alternative, in order to establish a record of the proceedings of the survey, as a means of saving the results of many years' labour from being altogether lost or forgotten.

A map of the Island, drawn upon a scale of 7 miles to an inch, is now ready for publication, and will shortly be issued. On this map the coast line is reduced from the most recent surveys of the officers of the Admiralty Coast Survey, and from our own work in

connection with the geological investigation. All the topographical features represented in the interior are from the work of the Geological Survey, except along the line of the proposed railway route, which was accomplished by the engineers under the direction of Sandford Fleming, C.M.G.

In order to illustrate the physical configuration of the Island, a limited number of these maps will be coloured orographically, which will be found convenient in a general way, as showing the relative heights over the sea-level of the surface of the land; while it also shows the relative depths of the sea over a large area off the coast.

I wish to take this opportunity of expressing my very sincere thanks to the officers of the Admiralty Coast Survey, especially Captains Kerr, Robinson, and Maxwell, for much valuable assistance and information, particularly in giving Mr. Howley and myself every facility for reference to their coast charts and other documents, which have been most serviceable data as starting-points for our surveys of the interior.

ALEXANDER MURRAY.

CRIEFF, PERTHSHIRE,
May 9th, 1881.

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GEOLOGICAL SURVEY

OF

NEWFOUNDLAND.

CHAPTER I.

REPORT OF SIR W. E. LOGAN, LL.D., F.R.S., &c., &c., ADDRESSED TO THE HON. F. B. T. CARTER, ATTORNEY-GENERAL, &c., ST. JOHN'S, NEWFOUNDLAND.

GEOLOGICAL SURVEY OFFICE,
MONTREAL, 1st *May*, 1866.

SIR,—Mr. Murray has submitted to me the results of his geological exploration in Newfoundland during the last two seasons; and it gives me much satisfaction to observe the progress he has already made in developing the general structure of the eastern part of the island. Before he commenced his labours, Mr. Richardson, under my instructions, had already visited the western coast, with the view of ascertaining facts to elucidate points connected with the geology of Canada. It was then ascertained that a trough of Lower Silurian rocks must underlie the northern part of the Gulf of St. Lawrence, gradually narrowing toward the Strait of Belleisle, one side of the trough rising on the coast of Labrador, while the other forms the western shore of Newfoundland from Bonne Bay to Cape Norman. On each side of the strait these rocks were found to rest on Laurentian gneiss; and the mass of this ancient system, which presents itself in this part of Newfoundland, was ascertained to extend from the neighbourhood of Bonne Bay to within 12 or 15 miles of Hare Bay, but its breadth was not determined. Mr. Murray's investigations have since proved that this mass of Laurentian rocks spreads in breadth to the Atlantic coast of the great northern peninsula of the island; that

the base of the Lower Silurian strata, sweeping round the northern extremity of the gneiss, comes upon the coast near Canada Bay, and again strikes into the land at Coney Arm, in White Bay, where these Lower are overlaid by Upper Silurian, followed by rocks of Devonian age. Farther to the south-east, the Laurentian and Silurian series become partially and unconformably covered by rocks of the Carboniferous age, in two or three separate areas, which have heretofore been mentioned by Mr. Jukes. One of them is upon Grand Pond, and another on St. George's Bay. In his traverse last year, from Hall's Bay to St. George's Bay, Mr. Murray traced the western margin of the more northern of these, for about 30 miles, and observed the more southern at several points on the north and south-east shores of the bay which has last been mentioned.

Having thus ascertained the general position of these Carboniferous areas, it is important to determine with as little delay as possible what workable seams of coal may be associated with them; and Mr. Murray proposes to devote the chief part of his investigations during the ensuing season to this end, as well as to trace, as far as he can, the outcrop-course of any seams he may discover.

The nearest known coal deposits to the Island of Newfoundland are the beds worked at Sydney, on the Island of Cape Breton; and it is not unreasonable to suppose it probable that there will be a general analogy in the character of the measures on the opposite sides of the water dividing them. At Sydney, between the base of the coal measures and the workable seams, there is a thickness of barren strata of between 3000 and 4000 feet; and if the same conditions exist in Newfoundland, it will depend upon the attitude of the strata whether we may expect the occurrence of coal beds there to become available to commerce. Mr. Murray observed a regular coal seam of six inches in thickness; but this would not be workable. Mr. Jukes has reported one of three feet; but at Sydney there are four workable seams, measuring altogether upwards of fifteen feet, in a thickness of 3000 feet, that at the bottom being three feet; and no time should be lost in determining such facts as will make it known whether these seams exist, or may be reasonably searched for by capitalists in the Carboniferous areas of Newfoundland.

Mr. Murray's explorations on the east side of the northern

peninsula, and Mr. Richardson's on the west, have shown that the Lower Silurian series in the northern part of Newfoundland is characterised by a great spread of that portion of it, which in Canadian geology has been termed the Quebec group. This group may conveniently be separated into three divisions,* the middle one of which has proved rich in metalliferous deposits, in its course from the southern Atlantic States of the American Union to Canada, and through Eastern Canada to Gaspé. The indications observed by Mr. Murray are sufficient to authorise the expectation that the formation will prove productive of these metalliferous minerals in Newfoundland; and the Tilt Cove and Terra Nova mines, which are both in serpentine belonging to the middle division, are evidences that a detailed investigation of the distribution of the Quebec group is only second in importance, in an economic point of view, to that of the Carboniferous series. The occurrence of serpentine in the more southern part of Newfoundland has been pointed out by Mr. Jukes in various isolated places; and it appears to be probable that this rock will, in most, if not all of these, be found to belong to the Quebec group. The scattered facts already thus known, prepare us to expect a great development of the metalliferous division of the group in the southern as well as the northern portion of the island, convincing me that a thorough knowledge of a great portion of the mineral wealth of the province will be vastly promoted by a careful and connected exploration and study of the Lower Silurian series.

I have now the honour to transmit to you the accompanying Report of his first exploration, addressed to me by Mr. Murray while I was in England last year. The study of it required a reference to a collection of specimens which had been forwarded to the office of the Canadian Survey for examination; and the death of my brother, soon after my return, forced me to postpone the consideration of it longer than I wished.

I have the honour to be, Sir,

Your most obedient servant,

W. E. Logan.

* The relations of this group and of its divisions are so important that I append a brief synopsis of them, in which the Lower Silurian strata of Newfoundland and the two basins of north-eastern continent.. America are compared.

CHAPTER II.

REPORT OF ALEXANDER MURRAY, ADDRESSED TO SIR W. E. LOGAN, F.R.S., &c., FOR 1864, UPON THE GEOLOGY OF THE EASTERN COAST OF THE GREAT NORTHERN PENINSULA, AND PORTIONS OF HALL'S BAY, NOTRE-DAME BAY, AND WHITE BAY.

LONDON, 11*th April*, 1865.

SIR,—In accordance with an arrangement made by yourself with the Government of Newfoundland, by which I was selected to make a geological investigation of that province, I left Montreal, accompanied by Mr. H. H. Beckett as an assistant, on the 18th May last, and reached St. John's, Newfoundland, on the 31st of the same month, when I immediately placed myself in communication with the Hon. H. W. Hoyles, Attorney-General, to receive final instructions.

It being your desire that the great northern peninsula of the island, where most of the sea-coast is well exposed, should be examined as a commencement of the investigation, the Provincial Government were pleased, on my recommendation, to charter a schooner of 27 tons burden, called the *A. M. W.*, of Harbour Grace, with a crew consisting of a pilot commanding, and four seamen for the service. It was not, however, until the 22nd June that the vessel was refitted, and ready for sea; and during the interval, I employed my time in partially examining that portion of the peninsula of Avalon lying between St. John's and Topsail Head in Conception Bay.

We finally left St. John's upon the 23rd June, and reached Twillingate, a port of some importance near the entrance to the Bay of Exploits, on the 27th of the same month, having been much detained on the voyage by fog and stormy weather. On the 30th June we reached Little Bay, where the examination was begun in earnest, at Terra Nova mine, and where advantage was taken of the opportunity to explore the coast and portions of the interior between that bay and Ming's Bight. After leaving Little Bay, we proceeded to examine the northern peninsula, making

excursions into the interior on every convenient occasion; and by the time this part of the work was accomplished, the season had advanced to the 3rd of October, after which we repaired to Twillingate to refit the vessel. Finally, a rather hurried excursion was made to Hall's Bay; and the Indian Brook, a large stream which falls into that bay, was ascended for a considerable distance, after which we sailed for St. John's, and reached that port on the 3rd of November.

Sequence and Distribution of the Rocks of the great Northern Peninsula.

The rock masses observed in the great northern peninsula are recognised as belonging to the following geological divisions, which are given in ascending order:—

1. Laurentian.
2. Potsdam group, } Lower Silurian.
3. Quebec group, }
4. Upper Silurian.
5. Devonian.

1. *Laurentian System.*

The rocks classed under this head occupy upwards of 50 miles of the eastern coast of the northern peninsula, extending from Little Coney Arm, in White Bay, to within a few miles of Canada Bay. About four miles to the southward of the entrance to this bay, they strike into the land, and keeping to the westward of the bay, and of the Clouds Mountains, which are intermediate, they run a northerly course. The most northern exposure of them which was seen, occurred between three and four miles west of the Long Arm of Canada Bay, on a brook joining the arm, towards the upper end. Here the strike still continues northward; but there is little doubt that the limit of the series, beyond this, will soon turn gradually westward, to join the most northern position, where Mr. Richardson observed the hills composed of it on his visit to the western side of the peninsula in 1862.

In an exposure of the series met with a little more than two miles up Salt Water Pond Brook, the rock, which is of a reddish colour, is fine grained, and is composed chiefly of flesh-red orthoclase

feldspar, with white quartz and brown or black mica. It is interstratified with layers consisting chiefly of fine black mica with grains of white quartz; and by these black bands it was easy to observe that the dip was to the eastward. In the two brooks which have been mentioned, there were no great exposures of the gneiss, but the loose blocks observed in the beds of the streams, and on the banks on each side, derived probably from the formation not far off, made it evident that what is given above is the general character of the gneiss in this part. Many blocks of greenstone were associated with those of gneiss, and on Salt Water Pond Brook, dykes of a similar description were seen intersecting the gneiss.

In Hooping Harbour the general mass of rock is gneiss; but at the mouth of the brook, which flows in at the head of the northeast cove of the harbour, there are heavy bands of what cannot be distinguished from granite, some parts of them reddish and others grey, according to the colour of the feldspar, which is sometimes in large tabular crystals, the quartz being whitish and in fine grains, while the mica is usually black and in small scales. On the east side of the cove these bands of granite alternate very regularly with thick beds of coarse black mica-slate, clearly showing the stratified character of the mass, and giving a dip of S. 88° E. $<$ 30°. Farther south, but on the same side of the harbour, there is a great amount of milk-white gneiss, deriving its colour from opaque white orthoclase feldspar and white translucent quartz, but having well-defined marks of stratification, in darker and lighter grey parallel streaks, deriving their colour from the presence of more or less black mica. At the head of the western cove, or arm of the harbour, there is a great mass of a somewhat coarse flesh-red granite, in which no stratification could be made out, but it was overlaid by finely laminated beds of gneiss, and those upon the north shore of the cove appeared to be nearly horizontal. The cliffs on each side of the western arm, which rise almost perpendicularly to the height of between 650 and 700 feet, are all of gneiss, with bands of mica-slate, large tabular crystals of flesh-red feldspar being often observed in the strata. The dip at the head of the western arm is S. 80° E. $<$ 25°, but there are numerous undulations and contortions which render it difficult to establish an average. In these cliffs, and generally in

the harbour, the gneiss is cut by many fine-grained greenstone dykes, some of which are of great thickness. One of them, on the east side of the harbour, measured 130 feet across. These dykes appear generally to be about parallel to one another, their course being N. 54° E. and S. 54° W. Small veins of pegmatite, consisting of flesh-red orthoclase feldspar with some grains of quartz, are abundant in some places. At the extremity of the cape, on the east side of the entrance to Hooping Harbour, copper pyrites was observed disseminated in a small mass of quartz, constituting a nest in the white gneiss of that part. No visible vein was connected with the mass, and it is only worthy of remark as showing that the rock is not destitute of this ore, which may possibly be found in larger quantity in some other place in the neighbourhood.

Between Hooping Harbour and Bay Fourchette the rocks seem to be all very much of the same character as those above described; but the strata composing the cliffs between this bay, and the banks on either side of the stream which falls in at its western extremity, appear to be less red in colour than those farther north, and the contortions which they show are more numerous. The highest point seen from the anchorage on the north side of the bay, rose up almost vertically from the water's edge to the height of 904 feet.

The gneiss at Grandevache is very much like that at Bay Fourchette. In some beds it is red and in others grey. It is in general fine grained, and frequent layers of whitish quartzite and black mica-slate are interstratified in it. The strata are cut by dykes of fine-grained greenstone; numerous veins of pinkish feldspar reticulate through the rocks, intersecting both the strata and the dykes, and cracks and joints in the rocks are frequently lined with a pellicle of specular iron ore. The prevailing dip of the strata is here about S. 70° E. $<$ 40°–50°.

Going southward, the limit of the Laurentian gneiss enters upon the land in a small bay about 2½ miles south of Devil's Cove, on the east side of White Bay; and between this recess and Little Coney Arm, a narrow strip of the succeeding formation separates it from the water. It is about a quarter of a mile from the water, at the head of Little Coney Arm, where the gneiss is red in colour, and rather coarse in grain. It is interstratified with

bands of black mica-slate, and a considerable mass of the latter rock, perhaps 500 feet in thickness, forms the eastern limit of the exposure. In the cliffs, a little back from the extremity of the arm, the strata are contorted, but the general dip of the gneiss is here nearly vertical, the strike being about north and south. At the mouth of a small brook, however, in the south-west corner of the arm, there are some beds of dark grey gneiss, which dip S. 46° E. < 55°.

From Little Coney Arm the limit of the Laurentian gneiss pursues a somewhat sinuous course southward, and the last exposures of it visited were met with about five miles westward of Gold Cove, near the upper end of White Bay. Here the gneiss is of a dark grey colour, and its constituents are greyish orthoclase feldspar and greyish quartz, with black hornblende and dark brown mica, usually in very minute scales. The strata are a good deal corrugated, and white quartz veins are numerous, some of them running in the strike of the rock, and others somewhat oblique to it, while the strata are intersected by many dykes of dark grey fine-grained greenstone. The general trend of the strata and of the hill ranges is here about south by west.

From this spot to that at which Mr. Richardson left the Laurentian gneiss, in tracing its limit south-eastward near Bonne Bay, the distance in a straight line, a little south of west, is about 30 miles. It is extremely probable that the same rock composes the country the whole way; but where the opposite sides of this Laurentian mass, which forms the backbone of the northern peninsula, will ultimately join, in their trend southward, can only be determined by future exploration.

The rocks which have thus been described are considered Laurentian, not merely from the lithological resemblance which they bear to the strata of that system in various parts of Canada, but also from the relation they are seen to have to the Lower Silurian strata, which unconformably cover them in the northern part of the peninsula. They there present an exact analogy with the conditions of the masses seen on the north side of the Strait of Belleisle, the gneiss of which is distant from the nearest part of that of Newfoundland not more than 40 miles, while it is uninterruptedly connected with the great continental spread of the system in Canada. In Canada the Laurentian gneiss is in some

parts interstratified with enormous bands of crystalline limestone, and it is usually in these, or in the vicinity of them, that are met with the Laurentian minerals of economic importance; while the valleys that are underlaid by the limestones often give a considerable amount of surface capable of settlement. These economic minerals are the magnetic and specular ores of iron, the ores of lead and of copper, apatite or phosphate of lime, mica, and graphite or plumbago. None of these bands of crystalline limestone have yet been met with among the gneiss of the northern peninsula; but as it is only the rim of the 3000 square miles of it there spread out, which has thus far been examined, the calcareous bands may yet be found in the interior, should the examination at some future time be carried into greater detail. It will be seen by the description already given, that the only traces observed of any of the economic substances mentioned, were thin leaf-like veins of specular iron ore in Grandevache Bay, and a nest of copper pyrites at Hooping Harbour.

2. *Potsdam Group.*

Immediately east of the Laurentian gneiss, in the neighbourhood of Canada Bay, the Clouds Mountains rise to a greater height than any part of the country for many miles around, and their bold and fantastic outline forms a picturesque and conspicuous feature, readily recognisable for a great distance. Three of the highest summits, on all of which the compass was affected by great local attraction, were found by triangulation to be 1173, 944, and 920 feet above the level of the sea. The first of these, called the Capped Mountain, is on the north side of Salt Water Pond Brook, and the other two on the south. The rocks composing these hills consist, at the base, of a great thickness of dark grey slates, not very well seen, but probably amounting to 1500 feet. These are followed by dark grey, and occasionally drab-coloured slates, with many interstratified conglomerate beds, not in general exceeding six inches in thickness, holding small quartz pebbles in the same slaty base. This mass, which may attain a thickness of about 500 feet, is surmounted by about 40 feet of a dark purplish-grey diorite, apparently of an amygdaloidal character, containing nodules and numerous small masses of impure epidote, and

jaspery peroxyd of iron, and is cut in many places by thin leaf-like veins of the same jaspery ore. The upper bed of this mass of strata, thus amounting to about 2000 feet, which we may designate as Division A, is seen at the summit of the more northern of the two hills which are south of Salt Pond Brook, from which the diorite slopes with the geographical surface, at an angle of about fourteen degrees, towards Canada Bay. The margin of the bay, however, from the point north of Weymouth Cove to Hell Mouth, a distance of about six miles, is composed of overlying rocks; while for six miles farther, to the Gouffre, it consists of those of the Clouds Mountain range. Between the Gouffre and Canada Harbour, the coast is again composed of the overlying rocks.

In the bed of Salt Water Pond Brook, at their junction with the Laurentian gneiss, the strata of the Clouds Mountain range are vertical; farther removed from the gneiss, but somewhat to the north-west of the brook, they are highly tilted, with an inclination to the north-eastward; but descending the brook to within less than a mile from its mouth, the beds gradually present a moderate degree of regularity with a dip N. 26° W. < 18°. Between this and the pond, there is an interval of concealment, of about three-quarters of a mile, which is succeeded by exposures of higher rocks around the pond, and at the entrance to Long Arm. From these exposures, the following ascending series of deposits is gathered, the base being at the mouth of the brook, and the summit at the point on the north side of the entrance to Long Arm. These rocks we may designate as Division B.

	Feet.
1. Yellowish and grey argillaceous and somewhat micaceous slate, and grey compact limestone, having a conchoidal fracture, interstratified with one another towards the middle, in beds of from 2 to 3 feet, with white and yellowish sandstone or quartzite in thin beds towards the top	300
2. Blue limestone, having a conchoidal fracture, in beds of from 5 to 10 inches, with a 1-foot bed of reddish variegated limestone towards the middle, almost made up of fragments of trilobites; among them *Olenellus Vermontanus* (Hall) occurs, and weathered surfaces of other calcareous beds in some parts show the remains of fucoids	400
3. Black and grey slate, in bands of from 15 to 20 feet, interstratified with beds of white sandstone, of from 5 to 7 inches thick, and of pale grey arenaceous limestone, weathering	

		Feet.
	yellowish, and probably dolomitic, in beds of from 5 to 10 inches thick near the base; the exposed surfaces of some of the calcareous beds are covered with small reddish nodules, which probably replace organic remains. These were observed at the entrance of Salt Water Pond	53
4.	Black or dark grey slates, many bands of them hard and silicious, interstratified with beds of quartzite. Some of the slates contain many specimens of a *Lingula*, which appears, according to Mr. Billings, to be a new species, but allied to *L. prima* (Conrad)	300
5.	Blue and grey limestone in beds of 18 inches and 2 feet ..	100
		1153

The locality in which *Olenellus Vermontanus* was observed was at the entrance to Long Arm; and the presence of this trilobite in deposit 3, with a brachiopod so nearly allied to *Lingula prima* in 4, leaves little doubt that the strata in the above section belong to the Potsdam group, of which the trilobite is peculiarly characteristic, both on the west side of the gneiss in Newfoundland, and on the north side of the Strait of Belleisle. Although the strata of the Clouds Mountain range were nowhere seen in immediate contact with this recognised part of the Potsdam group, yet as they apparently plunge beneath it, without any observed reason to suppose a want of conformity, they will both for the present be classed together.

The strata of the above section, in their strike south-eastward, come against those of the two hills south of Salt Water Pond Brook, belonging to the Clouds Mountain range, while the strata of the Capped Mountain run against the Laurentian gneiss. By this it is evident that there is here, on the south-east side of the valley of Salt Water Pond Brook, a great fault, throwing the measures up on the eastward side. The course of this fault is N. 53° E., and S. 53° W. The horizontal displacement produced by it appears to be between two and three miles, but the data are not sufficient to enable me to state with exactness the vertical amount. This upthrow carries a portion of the strata of division B to the point between Long Arm and Weymouth Cove; and the rocks already alluded to as forming the coast from this point to Hell Mouth, and from the Gouffre to Canada Harbour, belong to them. At Beaver Cove, which is intermediate between Weymouth Cove and Hell Mouth, the strata consist of sandstones or quartzites,

surmounted by dark grey somewhat calcareous slates, with a dip S. 20° E. < 22°-33°, probably corresponding with the upper part of B,3. The long point on the east side of Gouffre Cove is composed of limestones, pale grey at the bottom and white at the top, exposed for about 100 paces across the measures, in a cliff of from 100 to 120 feet high. In this, the strata dip at various high angles, presenting many corrugations, which render it difficult to determine the exact thickness, but it probably exceeds 200 feet. These limestones are supposed to be equivalent to those of B,5, with an additional thickness, and they are underlaid by a mass of disturbed and corrugated slates, which would occupy the horizon of B,4. Similar rocks appear to form the promontory on the west side of Canada Harbour. The limestones seem to be about the same thickness; and the upper part of them, being pure white and fine grained, and capable of receiving a high polish, would afford a considerable amount of good material for ornamental marble.

At the head of Canada Harbour, these white limestones are brought abruptly against slates, with quartzites and diorites, belonging to a higher formation, by a great downthrow fault, running S. 31° W. The position of the fault is marked by the occurrence of several caverns in the limestone, from one of which there issues a beautiful stream of clear cold water. This fault, crossing the entrance to Canada Bay, strikes into a small cove, on the inside of the point separating Bide Arm from the Atlantic. Its effect upon the strata carries the strike parallel with it, and on the inside of the point they are exposed in a highly disturbed condition, and divided from the slates and diorites of the higher rock by a narrow belt of bog or low springy land, which marks the position of the fault. The fault here appears to run N. 19° E., keeping a little inland from the eastern shore of Bide Arm, and nearly parallel with it towards the northern extremity of the arm. The exposures on Eagle Island, which is immediately west of the point separating Bide Arm from the Atlantic, consist, on the west side, of the slates of B,4, and on the east, of the pale grey and white limestones of B,5. The dip on the island is about S. 76° E. < 25°-32°, and the whole of the strata, together with the limestones in the channel, up to the fault, have an estimated thickness of 1300 feet; of this about 400 feet would belong to the slates,

and about 900 feet to the pale grey and white limestones, which is probably their total volume. As in the case of the limestones of Canada Harbour, of which they are evidently a continuation, with additional thickness, some of the beds are very white and compact, and would afford material available as ornamental marble; but the rock has a prevailing pale bluish tinge, and it is frequently streaked and spotted with pale blue and pale rose-red, which would probably be found an objection to its use in the higher works of art.

On leaving the north end of Eagle Island, the strike appears to make a sudden sweep to the north-westward; and at the point of the peninsula which divides Bide Arm from the main body of Canada Bay, a series of calcareous strata is exposed, which are considered an addition to the measures already given, and may be designated Division C. In ascending order they are as follows:—

	Feet.
1. Bluish-grey, white-weathering compact limestone, in a few beds of 2 and 3 feet, showing fine lines of lamination on the outcropping edges; the rock is penetrated by vertical forms resembling *Scolithus*, and on weathered surfaces there are scattered forms which appear to be obscure remains of fucoids	7
2. Pale grey limestone in two massive beds, penetrated by numerous forms resembling *Scolithus*. The rock has a conchoidal fracture, and is probably suited for marble	5
3. Pale blue hard limestone, presenting occasional obscure remains of fucoids on weathered surfaces	1
4. Pale grey white-weathering limestone, in two massive beds, showing vertical cleavage lines	8
5. Dark blue nearly black limestone, which weathers very white; it is penetrated by vertical forms, supposed to be *Scolithus*; the weathered surfaces of beds are covered with brown or reddish patches, supposed to be remains of fucoid or corals	6
6. Grey limestone filled with silicified sub-globular forms, supposed to be organic remains	1
7. Bluish-grey compact limestone, in beds of from 1 to 2 feet thick, with scattered forms on weathered surfaces, supposed to be the remains of fucoids	11
8. Brownish impure limestone, not well exposed	21
9. Bluish hard limestone with a conchoidal fracture, in beds varying from 1 to 4 inches in thickness	18
10. Pale bluish limestone in alternating thick and thin beds, varying from 1 foot to an inch. This forms the crest of a bold cliff facing the sea	30

	Feet.
11. Blue white-weathering limestones in two massive beds	6
12. Bluish-grey brown-weathering slates, interstratified with beds of bluish limestones, varying in thickness from 10 to 15 inches, the weathered surfaces of which are sometimes covered with obscure organic forms, supposed to be fucoids	66
13. Bluish-grey white-weathering limestone in one massive bed ..	10
14. Dark brown slates, and bluish and whitish limestones, in alternating beds; the uppermost bed of limestone weathers to a straw-yellow, and is probably dolomitic	50
15. Blue and dark grey massive limestones interstratified with brown slates in equal quantities, the whole mass forming an undulating surface in the interior of the country. The limestone, at the summit, holds numerous nodules of black chert, weathering yellowish, which are arranged in layers parallel with the stratification	660
	900

At the base of the cliff, where the section commences, the dip is S. 44° E. < 26°, and at the top of the outer crest it is S. 44° E. < 34°; but in Bide Arm, some distance from the point of the peninsula, the inclination is irregular and sometimes approaches verticality, and the thickness of the latter part of the section may be understated.

Nearly the whole of the peninsula between Bide Arm and the main body of Canada Bay is composed of the rocks of this division. The cherty limestone at the top is seen towards the extremity of the arm, on the west side, where the dip is S. 73° E. < 85°; while the rocks at the base of the division strike along the west side of the peninsula, gradually turning more north, and leaving room for a part of the white limestones of the previous division at two points on the coast included in the first three miles. The strike is nearly due north beyond this, for five miles, thence turning gradually more eastward towards the Salt Water Pond fault.

Following the formation northward from the section of Salt Water Pond, both sides of Long Arm seem to be composed of the Division B. In the beds of the brook flowing in near the upper end, on the west side, are seen the fucoidal limestones of B,4, and at the mouth of the brook there occur the limestones, whose surfaces are covered with the reddish nodules characterising the

base of B,5. The formation was not traced into the country northward from this, and nothing of it was seen in Hare Bay, though it is probable that the upper part of it approaches the coast somewhere near to West Brook, in the south-western part of the bay.

The total thickness of the Potsdam group, as far as collected from the examination of Canada Bay, appears to be as follows:—

	Feet.
A. Clouds Mountain bluish-grey slates, conglomerates, and diorite	2500
B. Salt Water Pond bluish-grey, black, blue, reddish and white limestones, yellowish-grey and black slates, and grey and white sandstones, in some parts holding *Olenellus Vermontanus*, *Lingula*, *Scolithus*, and fucoids	2000
C. Light and dark blue limestones, and brown slates with cherty limestone at the top	900
	5400

Between the cliff showing the cherty limestones in Bide Arm, and the recognised strata of the succeeding formation, there is a depression which appears to run all the way to North-east Arm. The rocks under this are concealed, and may add something to the volume of the Potsdam group.

In the neighbourhood of Salt Water Pond, the strata of the Clouds Mountain range have a direct breadth of nearly three miles, but at the Gouffre the breadth is not more than about three-quarters of a mile. Whether this is to be wholly attributed to an increase of the dip, or whether it may be partly due to a thinning of the mass, is not quite certain. But in the next exposures southward, in which strata belonging to the Potsdam occur, the Clouds Mountain beds cannot be recognised with any degree of certainty. The localities of these exposures are at Great and Little Coney Arms. It has already been mentioned that the Laurentian gneiss, back from the extremity of Little Coney Arm, terminates in a considerable mass of black mica-slate. Between this and the succeeding exposure of rock, there occurs an interval of concealment, in which a depression runs in the strike, both northward and southward from the arm, forming on the south side the valley of a small stream. On the east side of the depression there is seen

another series of rocks, of which the following is an ascending section:—

		Feet.
1.	Pale bluish-grey mica-slates with yellowish-brown iron stains, softer and more finely laminated than those of the Laurentian series, and more uniform both in colour and texture ..	300
2.	Pale bluish-grey iron-stained mica-slates, interstratified with bluish and blackish compact limestones, in beds of from 1 to 3 inches thick, and occurring at intervals of from 2 to 4 feet or more	430
3.	Blue limestone in beds varying from 10 to 15 inches	50
4.	Blue and grey compact limestone in beds varying from 8 inches to 2 feet in thickness, with forms on weathered surfaces, supposed to be fucoids	30
5.	Measures concealed	70
6.	Pale grey black-weathering limestone in beds of from 1 to 2 feet, with cleavage joints in two directions, giving a brecciated aspect to the rock	110
7.	Pale grey black-weathering compact limestone in beds of from 4 to 5 feet thick	60
8.	Cream-white compact limestone, with a conchoidal fracture, in a single bed, probably fit for the purposes of marble ..	6
9.	Pale blue drab-weathering limestone in beds of 3 or 4 inches thick, separated by thin layers of greyish-drab slate	15
10.	White, very fine grained, compact limestone, with a conchoidal fracture, in a single bed, with vertical cleavage joints running at right angles to the strike	15
11.	White compact limestone, with a conchoidal fracture, in beds of from 2 to 3 feet, separated by thin layers of calcareous slate; the rock is probably fit for the purposes of marble ..	35
12.	Brown slates with interstratified white and yellowish fine-grained compact limestones, in beds of from 12 to 18 inches thick, with a 2-feet band of darker, softer, and more finely laminated slate at the top	75
13.	Greyish-drab micaceo-calcareous slates, interstratified with pale blue and grey and whitish compact limestone, in beds of 2 feet thick and upwards	75
14.	Blue compact limestone in a single bed	15
15.	Pale grey fine-grained compact limestone, in beds of from 1 to 3 feet thick, parted by thin layers of grey slate	100
16.	Pale grey black-weathering fine-grained limestone, in beds of from 1 to 2 feet in thickness, bordered by thin partings of blackish-grey slate	110
17.	Greyish and bluish limestone in massive beds, separated by thin layers of slate	190
18.	White compact hard limestone, in beds of from 3 to 5 feet, spotted yellow from decomposing iron pyrites	90
		1776

This section is obtained from the cliffs on the north side of Little Coney Arm, where the dip is E. < 55°-70°, and where it extends across the measures for a distance of about 750 yards; at the eastward end of the line, the strata turn up again, with an opposite dip, forming a synclinal; the east side of which gives a repetition of most of the calcareous part of the section, before reaching the point at the entrance of the arm on the north side. A short distance along the coast from the corresponding point on the opposite side, the strata are seen to turn over again, forming an anticlinal, and, with an east dip, the limestones plunge under the surface of Great Coney Arm. The character of the limestones of this section, and their relation to the Laurentian gneiss, render it pretty certain that they are a continuation of the calcareous rocks of Canada Bay, and therefore belong to the Potsdam group. From the axis of the anticlinal which has just been mentioned, the water of Great Coney Arm is about seven-eighths of a mile wide, and on the opposite side there rises an escarpment composed of whitish, granitoid, very quartzose mica-slates. These have a breadth of about a mile and a quarter, and then sink beneath overlying unconformable rocks. They present a somewhat uniform character for their whole breadth, as seen at the extremity of Coney Arm Head. They are somewhat corrugated, but generally dip to the eastward at a high angle. Supposing that the average inclination of forty-five degrees be given them, and that they are repeated by undulations, between two and three times, they would have a thickness of probably 1500 or 2000 feet. Whether they belong to the Potsdam group, it is difficult to say. No rocks like them have been anywhere found in this group, and they more resemble some of the strata of the metamorphosed Sillery series, as seen, but not in any such great volume, in the eastern townships of Canada. Should they prove to be of this series, then the intermediate strata of the Quebec group might be supposed to be buried beneath the waters of Great Coney Arm. But there is here scarcely room for them, and no certain traces of them have yet been met with in the run of the measures farther south in this neighbourhood. It would therefore be necessary to allow the existence of a great downthrow fault to bring the Sillery series into the position occupied by these mica-slates.

The mica-slates gradually approach the limestones in their

southward trend, and about a mile up a considerable brook, which flows into Great Coney Arm at its southern extremity, the distance between them is about the third of a mile. This position is upwards of a mile west of Frenchman's Cove. At the extremity of Jackson's Arm, which is 2½ miles farther south, the mica-slates have a breadth of about a mile, in the western half of which they form high ridges inland, while the limestones rise about half a mile farther in, on the west side of the valley lying between them. These formations were here left trending southward, but they were not met with again in their southern distribution. The limestones are supposed to accompany the Laurentian gneiss in its course west of Sop's Arm, but the mica-slates did not appear on the coast at the extremity of it.

At Hauling Point, on the east side of White Bay, there is an exhibition of limestone. The colour of the rock is for the most part white, but sometimes a pale rose-red; some parts of it weather yellowish, and these are occasionally dolomitic. It is coarsely crystalline, and mica is disseminated through it; and although probably a good material for burning into quicklime, it is inapplicable to any structural purpose. The dip of the rock is northwestward, and at the lower part it becomes interstratified with mica-slate. On the east side of a cove, inside of Hauling Point, which would be beneath the previously mentioned rock, a coarse quartzose granitoid mica-slate is met with, and a similar rock prevails along both sides of the Western Arm up to its extremity, a distance of nearly 3 miles across the measures. Here strong hard bands of micaceous gneiss come in, bearing some resemblance to that of the Laurentian series; the mica-slate which overlies them, strongly resembles that of Coney Arm Head. If it be supposed that the gneiss of the Western Arm is Laurentian, it would be fair to infer that the mica-slate of Coney Arm Head must be older than the Sillery series, and be brought into place by an upthrow, instead of a downthrow fault. The limestone of Hauling Point, notwithstanding its very different crystalline condition from that of Great and Little Coney Arm, might then be supposed to represent it; and the coarse quartzose granitoid mica-slate on the opposite sides of White Bay to be in the form of a trough, with the Potsdam group above it. It will be necessary, however, that a great deal more should be ascertained of the rocks

to the eastward of White Bay, before such a question can be satisfactorily determined.

3. *Quebec Group.*

Returning to Canada Bay, we find in the north-east corner of Bide Arm a series of grey and black limestones, many of them weathering yellow, and probably magnesian. Between these and the cherty limestone at the top of the previous formation, there intervenes the breadth of the arm; and as has been already mentioned, a corresponding depression, under which the rocks are concealed, runs from the north-west corner of Bide Arm to the North-east Arm. Of this arm the east side is wholly covered with boulders; a good deal of the west also is concealed; but near the mouth of the brook, at the northern extremity, there are a few exposures of limestone, and it is here that the base of the previous formation would strike the continuation of the great fault of Salt Water Pond. On both sides of the North-west Arm, but especially on the west, there are exposures of limestone; and near the outlet of the brook, which falls into this arm at its northern extremity, two massive beds of the rock are met with. The lower one is deep blue, and weathers light yellow, being probably magnesian. It contains a number of grey, blackish-weathering, rudely subspherical concretions. Some of them are of enormous size. One of them measures 9 feet in diameter, and several were observed measuring 3 feet. The upper bed is of a pale grey on fracture, but weathers yellowish brown, being probably magnesian. The dip of these beds is N. 50° E. $< 10°$; and about half a mile farther up the stream, higher strata occur, consisting of about 30 feet of grey and white limestones, in beds of from 3 inches to 3 feet, some of them weathering yellow. The exposed surfaces of many are covered with obscure remains of fucoids, and other fossils; and among the latter Mr. Billings recognises, in addition to fragments of trilobites and orthoceratites, *Maclurea canulata* (Billings), *M. speciosa* (B.), and *M. Normani* (B.). These fossils belong to the Calciferous formation, which is the lowest of those that are classed under the designation of the Quebec group. It would thus appear that the base of the group stretches from Bide Arm to the North-west Arm, with a north-western trend; and it is probable that, after running a few

miles farther with this strike, it will turn up northward for Hare Bay.

Belvie Bay, which forms the south-western part of Hare Bay, has a very irregularly indented coast. It presents many deep coves, and many long sharp promontories, and it is studded with many islands. The exposures of rock are numerous, and a good transverse section was obtained extending from the neighbourhood of the Southern Arm, on the west side of the bay, to Springs Arm, which is on the south side of Hare Bay and somewhat behind the eastern limit of Belvie Bay, the distance being 8½ miles. The following appears to be the series of deposits which occur on it, as gathered from the exposures on each side of the line, and they are given in ascending order. The lowest deposit of the section, however, does not reach the base of the formation. How much is wanting is uncertain, but it cannot be less than some 500 feet.

	Feet.
1. Grey yellow-weathering limestone, probably magnesian, in beds varying from 3 inches to 1 foot, with occasional thin partings of calcareous slate; on weathered surfaces there occur obscure remains of fucoids, with other fossils	600
2. Black limestone in beds varying from 6 to 12 inches in thickness, followed by dark grey yellow-weathering, and probably magnesian limestone, in beds of from 8 inches to 1 foot, separated by thin layers of greenish calcareous slate, which at the summit become of considerable thickness, and are interstratified with thin beds of dark grey yellowish-weathering limestone; the whole mass is terminated by a bed of brownish-black bituminous limestone. The limestones are for the most part fossiliferous, and among the fossils are *Murchisonia simulatrix*, *Maclurea Normani*, *Piloceras Wortheni*, *Orthoceras Allumettense*, and *Bathyurus Nero*	260
3. White compact limestone, with a conchoidal fracture, in beds varying from 4 to 8 inches, aggregations of which alternate with beds of pale grey somewhat shaly limestone, of about the same dimensions. The grey limestones are fossiliferous, but the fossils are so fragmentary that it is difficult to determine them	580
4. Dark grey yellow-weathering limestones, probably magnesian, in beds varying in thickness from 3 to 8 inches, separated from one another by dark brownish yellow-weathering calcareous shales in thicknesses of from 6 to 12 inches	180
5. Dark brownish yellow-weathering calcareous shales, with thin occasional bands of dark grey yellow-weathering limestone ..	260

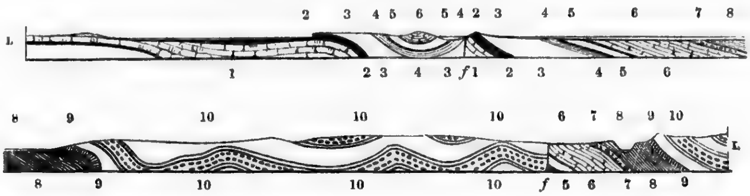
	Feet.
6. Greenish calcareous shales interstratified, at considerable intervals, with thin bands of grey yellow-weathering limestone, exhibiting occasional faint traces of fucoids and other fossils, among which a *Holopea* was met with in Springs Arm. In several parts of the breadth from which this thickness is calculated, there are intervals of concealment	500
7. Brownish conglomerate, holding pebbles of white quartz, and fragments of black slate and bottle-green diorite. The whole is studded with cubic crystals of iron pyrites, which cause the exterior to present a rusty brown colour	20
8. Black slates with a cleavage independent of the bedding, and probably fit for roofing-slates in some parts of the thickness .	1100
9. Yellowish-white dolomite weathering brownish-yellow, in beds varying from 2 to 3 feet in thickness, separated by beds of grey yellow-weathering hard slates, of from 3 to 5 inches thick. The dolomite is very fully studded with cubes of iron pyrites	200
	3700

Above this there occurs a series of interstratified diorites, quartzites, and slates, with some bands of conglomerate having calcareous and other pebbles. The whole mass is very much corrugated; it is therefore difficult to estimate its thickness, but it probably does not exceed 400 or 500 feet. On the north side of Hare Bay, in How Harbour, a similar series of altered rocks is seen, overlaid by a mountain mass of serpentine. The hill in which the serpentine occurs has a vertical height of 500 feet above the sea, with a horizontal distance of half a mile from the outcrop of the base to the axis of the hill, and a dip towards the axis of twenty degrees: allowing for possible undulations, this would give 500 feet more, so that the volume of the serpentine may be 1000 feet.

The thickness from the base of the group to the summit of the black slates (8) would thus be about 4000 feet, and the dolomites, diorites, and serpentine, 1600 or 1700 feet, making a total volume of 5600 feet. In the General Report of the Geology of Canada, published in 1863, the Quebec group series, on the west side of the northern peninsula, to the summit of a mass of black slates holding compound graptolites, to which the black slates of Belvie Bay are supposed to be equivalent, is given as about 4000 feet thick, while the diorites and serpentines are estimated at 1000 feet.

It will be seen from the accompanying plan and section how the measures are distributed on the coast and islands of Belvie Bay, and the general attitude they present in the exposures. Although the usual attitude of the beds shows but little disturbance over the greater part of the area in the vicinity of Belvie Bay, there is nevertheless evidence of two dislocations of considerable magnitude. One of these was observed at the point between Shoal Arm and the main body of the bay, where the black limestones, sinking beneath the surface on the west side of the promontory, are brought up again on the east side of a small synclinal, from a depth of about 200 feet. The other is on the west side of Springs Arm. Here the greenish

SECTION, BELVIE BAY, HARE BAY.



Horizontal and vertical scale, an inch to a mile.

1. Grey magnesian limestones.
2. Black limestones.
3. White limestones.
4. Dark grey magnesian limestones.
5. Brownish calcareous shales.
6. Greenish calcareous slates.
7. Brownish conglomerates.
8. Black slates.
9. Yellowish-white dolomite.
10. Diorites, dolomites, &c.

L. Sea level.
f. Faults.

calcareous slates and grey limestones (6) are brought from beneath, on the east, and placed in juxtaposition with the diorites overlying the black slates (8), the amount of displacement being between 1500 and 2000 feet. These faults appear to be nearly parallel to one another, their course being about S. 23° W.

From the promontory south of the Western Arm to the Northern Arm, the coast of Hare Bay presents a beach, composed in general of sand and limestone gravel, with a flat wide-spread marshy country behind it, studded with innumerable ponds. There are no exposures of rocks along it, until on reaching a cove

about a mile and a half to the westward of the Northern Arm, where the limestones, of which a section has been given, are repeated, and compose the promontory and the island between the cove and the arm. The whole of the calcareous strata are comprehended in a distance of about a mile and a half across the measures, and among the fossils obtained from them were *Murchisonia simulatrix, Maclurea speciosa, M. crenulata, Piloceras Canadense, Orthoceras* —— ? and *Bathyurus* —— ? with several other species of gasteropods and cephalopods, including a new species of *Lituites*, but all in a fragmentary condition. The dip is here eastward, with a somewhat regular slope of twenty-four degrees across the measures containing the limestones, giving a thickness of about 3000 feet. At the north-eastern end of the island which has been mentioned, the limestones are overlaid by a small amount of the black slates; but between the base of these, and a mass of diorites, which appears on the opposite side of the Northern Arm, there would be room for a thickness of the black slates equalling 1000 feet. The breadth and dip of the diorites, and their accompanying rocks on the east side of the arm, would give them a thickness of between 400 and 500 feet; and it is here that the serpentine mountain overlooking How Harbour seems to show, as has already been stated, a thickness of about 1000 feet.

From the head of the Northern Arm the diorites run along the coast for 7 or 8 miles, apparently crossing the mouth of How Harbour in their course. It is probable that they then re-enter upon the land, and turn up to the north-east. In the north-western part of Hare Bay the diorites thus appear to form the extremity of a trough, of which the serpentines constitute the centre. To the south of the south-eastern part of Pistolet Bay Mr. Richardson observed mountains of serpentine, which probably form the northern extremity of this synclinal range. In How Harbour the black slates, interstratified near the summit with conglomerates holding numerous pebbles of limestone, greenstone, and flat fragments of harder slates, rise from beneath the diorites in an irregular dome, and around the harbour the serpentine is arranged in several bold projecting mountain escarpments, while one mass, on the west side of the harbour, near the entrance, forms an isolated hill.

Within the harbour, the black slates were often marked by the presence of iron pyrites, and in some of the beds near the interstratified conglomerates, the quantity sometimes seemed almost sufficient to be made economically available. The diorites also often appeared to abound with the same mineral; and on the west side of the entrance to the harbour there were some indications that copper pyrites occasionally accompanied it.

On an excursion to the north-westward, extending between 4 and 5 miles from the cove at the base of the limestones, over a flat country, studded with clumps of small spruce and balsam fir, of which the trees seldom exceeded 20 feet in height, with moss and marsh and innumerable small ponds occupying the intervals, the strata met with were limestones, spread out in nearly horizontal layers. Bare surfaces of rock occasionally extended over areas of a square mile; these generally exhibited fragmentary fossils, of which, from the hardness of the rock, it was difficult to obtain specimens. They consisted, however, for the most part of convoluted shells and orthoceratites, and much resembled the species already mentioned. The general surface seemed to be scarcely more than 20 or 30 feet above the sea, and only one exception to the dead level was met with, in a hill of limestone which rose to about 100 feet. As seen from the highest hill over How Harbour, a country of the same character appeared to extend northward to Pistolet Bay, rising over the water of which four icebergs could be counted, whilst a little to the left the mountains of Labrador presented a faint blue undulating line over the horizon. A similar dead level extended to the westward as far as the eye could reach; but over this level, to the south-west, there arose in the distance a range of mountains, the nearest point of which appeared to be from 20 to 25 miles distant, being probably the most northern part of the area occupied by the Laurentian rocks.

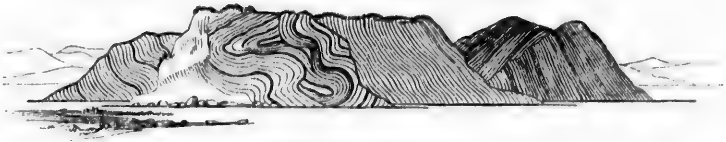
On the north side of Hare Bay there is a portion of the coast, between the point at which the diorites re-enter upon the land, and Ireland Cove, that has not been examined; but, as seen from the deck of the schooner, it presented an abrupt cliff to the sea, rising to a height of between 20 and 30 feet, maintained evenly for 4 or 5 miles. From this the surface in the interior gradually rose to a height of 150 or 200 feet, forming a valley running north-

eastward between two parallel ranges of higher ground. It was supposed possible that the coast might here be occupied by the black slates. To the east of Ireland Cove the coast gradually becomes more bold, and an examination was made of it about 2 miles from the cove in that direction. The rock consists of a greenish, hard, splintery slate, breaking into long fragments; and in a small peninsula extending about 100 yards out from the main run of the shore, there was observed an exposure of about 90 feet across the measures, in which the slates appeared to have a nodular structure, presenting ovoid or reniform masses, pressed one upon another, which in the four feet next the shore were partially separated by thin, whitish, reticulating strings of calcareous matter, giving to the surface the aspect of marbled paper, and over this occurred a band of about 40 feet of a purplish maroon colour. The dip of the slate in this neighbourhood was S. 57° E. $< 45°$; but going eastward it appeared to undulate, and the slate occupied the coast for a distance of three miles to the eastward of Swill Cove.

These slates continue along the coast, forming the point north of the entrance to Goose Cove, as well as the whole of the peninsula south of the cove, forming Goose Cape; here they appear to have a north dip, as ascertained at the summit of the highest point of the peninsula, which is 380 feet above the sea, and stands directly south of the isthmus. North of the peninsula the rocks of Goose Cove are green and grey jaspery slates, and they are interstratified with many thin bands of quartzite. Among these are some thicker bands, which assume the character of fine conglomerates, from the presence of small pebbles of white translucent quartz. Epidote is associated with these slates, sometimes running in small patches with the slates, and sometimes reticulating through them in small veins. White quartz cuts the slates and quartzites in thin irregular veins, and occasionally occurs in nests or bunches in the rocks, associated with copper pyrites. One of these bunches or patches, of a lenticular form, measured about three feet in length, with a breadth of a foot in the middle. The copper ore was irregularly disseminated in small masses, the largest of which was about two inches in length by a quarter of an inch thick. The rocks, here and elsewhere in the neighbourhood, appear to be very much contorted, rendering it next to

impossible to determine their volume. The following sketch of some of the smaller convolutions was taken in the north-east corner of Goose Cove. It represents a mass of rock, which occurs in a cliff about 50 yards long by about 20 feet high.

CONTORTED STRATA.



GOOSE COVE, HARE BAY.

A footpath leads from the north-east corner of Goose Cove to Crevallière Harbour, running northward, the distance being about 2 miles. The summit of a hill 553 feet above the sea, to the east of the path, about half a mile from the cove, is composed of black hornblende slate; the breadth is about 100 yards, and the dip is here S. 65° W. < 28°. The thickness of the mass would thus be about 130 feet. The summit of another hill, called the Sugar Loaf, distant about a quarter of a mile southward in the strike, appeared to be composed of the same rock, but what geological place it has in relation to the Goose Cove rocks is uncertain; it is probably beneath them. On the footpath, the rocks, seen every now and then for the whole distance, were green slates much resembling those of Goose Cove; but, arriving at Crevallière Harbour, a cliff of about 20 feet in height displayed a bed of quartzite at the bottom, surmounted by a band of black arenaceous very impure limestone, followed by a mass of green soft slates, which appeared to be chloritic; cracks and fissures in the rock were frequently filled with calc-spar. The dip was S. 78° E. < 10°. The facts ascertained in the neighbourhood of this part of Hare Bay appear too scanty to determine the exact geological relation of the masses in the Quebec group; but the hard green slates, of which they chiefly consist, resemble in aspect the green diorite slate of the eastern townships of Canada; and the hornblende of Sugar Loaf Hill would appear to favour the supposition that they are of a dioritic character here, and belong to the middle division of the group. They would thus belong to that part of the group which holds the serpentines, and is so often found rich in copper

ores and other metalliferous minerals. No great mass of serpentine, however, was seen in the neighbourhood, although it is probable that such may occur more in the interior.

On the south side of Hare Bay, about a mile to the east of the diorites of Springs Arm, where the section across Belvie Bay terminates, the dip of the measures is S. 25° E. < 60°, and a line across the measures running from Hare Bay to Maiden Arm, gives the following section, reduced to vertical thickness:—

	Feet.
1. Greenish, hard, jaspery slates	500
2. Pale sea-green quartzite. On the exterior it is opaque white from the effects of fire, but for the sixteenth of an inch beneath the surface it is dark brown. This mass is divided into beds of from 1 to 2 feet by darker green hard slates, in beds varying from 6 to 15 inches, and thin veins of white quartz run with the strike	150
3. Blue, jaspery, very hard and compact slate	5
4. Greenish, hard, compact slate	120
5. Dark grey quartzites, including small rounded grains or pebbles of white quartz, giving it a speckled aspect; fine grains of iron pyrites are scattered through the rock, which is divided into beds varying in thickness of from 10 to 15 inches, separated by green hard slates of from 1 to 3 feet	70
6. Green hard slates interstratified at intervals of from 1 to 100 feet by layers of greenish-grey brown-weathering diorite of from 1 to 4 feet in thickness	500
7. Black compact slates in layers of from 12 to 18 inches, interstratified with dark grey slate weathering rusty brown. The measures beyond this become concealed, and the mass of black slates may be much thicker than given	30
	1375

Although the dip was all one way, it is not impossible that the beds 1 and 6 may be the same, from a break or an undulation, and the black slates may be those beneath the diorites. They occur again on the east side of the arm, toward the exit, where they have a thickness of 300 or 400 feet. It is probable that the green slates and diorites overlying the black slates are kept at the surface by undulations, all along the coast to the Fishot Island; and at Havre du Four a series of rocks belonging to this horizon, consisting of grey sandstones and conglomerates with pebbles of white quartz, interstratified with bands of green diorite slates and overlaid by a considerable mass of similar slates, showing brown and black bands

in addition to green, present the folds illustrated in the accompanying transverse vertical section.

Similar rocks are displayed along the coast to St. Julien, but here there appears to be a change. The island of St. Julien, and

SECTION, HARBOUR DU FOUR.

Horizontal and vertical scale, 3 inches to a mile.

a. Quartzites and fine conglomerates.
b. Sandstones and green slates.
c. Black, green, and brown slates.
L. Sea level.

the several promontories which divide the bay into the Great and Little Harbours, and Great Goose Cove, consist of coarse greyish or greenish sandstones and conglomerates, interstratified with green, purple, and black argillo-arenaceous slates. The sandstones are composed of rounded grains of transparent, translucent, and opaque white quartz, with others of white feldspar, held together by a sparing quantity of a grey or greenish argillaceous matter, with a very small amount of carbonate of lime. The same minerals compose the conglomerates, in which the pebbles, consisting of quartz, are in general about the size of peas, but in some bands, as in one which runs through the length of St. Julien Island, attain a diameter of between 2 and 3 inches. The strata in general dip nearly south-east at high angles, and stand in many instances in a vertical attitude. At the head of the eastern harbour, on the east side, a series of black and grey arenaceous slates, running parallel with the shore, have a general south-east dip, but display many twists and corrugations. Where the slates are crossed by streamlets of water, they present a rusty brown colour, from the decomposition of iron pyrites, which is disseminated in the rocks, and they are cut by large white quartz veins, without the exhibition, however, of any metalliferous ores. Sandstones and fine conglomerates occur on the west side of the bay; and on this side, at a spot bearing N. 80° W. from the north point of St. Julien Island, the strata, consisting of conglomerate

beds varying from 8 to 18 inches in thickness, parted by thin layers of green arenaceous slate, are cut by numerous quartz veins which run in various directions. One of these, traceable from the shore for between 30 and 40 yards, is seen in the cliff, and holds yellow sulphuret of copper, while the rock is much stained with the blue and green carbonates resulting from the decomposition of the sulphuret. The ore is a nearly pure sulphuret, and it appears to be pretty continuously distributed in the vein, which in the cliff is rarely over 3 inches wide, though it seems to increase a little proceeding inland, before it becomes covered up.

On the promontory dividing the two harbours, a series of black slates is interstratified with bands of sandstone of between 2 and 3 feet thick, standing in a nearly or altogether vertical attitude, and from unequal wear of the sandstones, their jagged edges start up in prominent separate masses in the plane of the bed, many feet above the general level, and several of these, in succession, in some places, appear like colonnades. These sandstone pillars strongly resemble those at Tourette near Cape Chatte, on the St. Lawrence; and the rocks of the two localities have so much in common, that it is probable they belong to the same horizon. The St. Julien sandstones would thus appear to belong to the Sillery series, which constitutes the upper part of the Quebec group.

Croc Harbour is situated between 4 and 5 miles to the south-west of St. Julien. At the head of the harbour, and for a considerable distance up the brooks which fall into it there, the measures are chiefly black calcareous slates, with beds of limestone conglomerate, apparently near the top. These rocks are vertical, or highly tilted, with an inclination eastward; they have a breadth of more than a mile, within which distance, however, there may be more than one repetition. They are succeeded to the eastward by quartzites and diorite slates with beds of argillite passing into finely laminated micaceous slates. These rocks probably belong to the lower and middle divisions of the Quebec group. But near the mid-length of the harbour there are evidences of a fault running north-easterly, and slightly oblique to the stratification. It appears to be a downthrow to the south-eastward, and it brings in a series of rocks similar to those of

St. Julien, consisting of sandstones and conglomerates interstratified with slates, which, in addition to green and purple, are in some places red, thus establishing a still further resemblance to the Sillery series. The general bearing of the fault would carry it to the west side of St. Julien Bay, perhaps a little in from the shore, and it would thus run by the small vein of copper ore which has been described as occurring there. Though the quantity of the ore is not sufficient to be economically available, the vein might become of some significance should it be found to have any connection with the fault; for this being a displacement of some importance, it might possibly give an opportunity for a larger secretion of the ore.

In Croc Harbour the fault comes to the shore near the Genille fishing establishment, and on the opposite side it probably runs into Pelletier's Cove. In the peninsula of Cape Rouge, some 6 or 7 miles to the southward, there occurs a fault, with a downthrow to the south-east, affecting a higher series of rocks, to be hereafter described. This is probably a continuation of the Croc Harbour fault, in which case it would come out upon the coast about 5 miles south of the harbour; and the coast that far probably belongs to the Sillery series. This series was observed by Mr. Richardson, some short distance to the east of Pistolet Bay, and from its trend in that part, it was supposed that its base would run into the Atlantic at St. Lunaire Bay.

With the exception of the peninsula of Cape Rouge and that of Cape Fox, the coast appears to be formed of rocks of the middle division of the Quebec group to the entrance of Canada Bay. It has already been mentioned that between Eagle Island, and the point at the northern side of the entrance to this bay, a fault brings the white limestones of the Potsdam group, on the west, against the diorites of the middle division of the Quebec group, on the east; and that the same condition of circumstances is observable in Canada Harbour, on the south side of the bay. From Canada Harbour the bearing of the fault would carry it to a cove on the coast, between 3 and 4 miles to the southward, and here the fault brings the diorites of Canada Head, belonging to the middle division of the Quebec group, against the Laurentian gneiss, without the intervention of the lower division of the Quebec group, or any part of the Potsdam. From this it would

appear that this dislocation must be here a downthrow to the eastward of about 8000 feet. It diminishes, however, towards Canada Bay, where the displacement appears to be about 4500 feet. From the convergence of this great dislocation and that of Salt Water Pond, it is probable they would meet before reaching Hare Bay. The Salt Water Pond fault is a downthrow to the westward. Its influence, therefore, would diminish that of the Canada Harbour fault. We accordingly find that the dislocation near Springs Arm on Hare Bay, which is probably a continuation of the other two united, is only from 1500 to 2000 feet. Where the Springs Arm fault strikes into the land, on the north side of Hare Bay, has not yet been ascertained, but it will probably be somewhere near Ireland Cove. The study of these great breaks in the rocks of the country is a subject of great interest, since independent of the evidence they give of the great dynamic forces which have fractured the earth's crust, and the influence they have on the geographical distribution of the geological formations, they may be found to possess an economic value; for they must originally have been connected with extensive fissures, and where they traverse rocks charged with metalliferous minerals, they may have given opportunity for the secretion of corresponding ores, and be found to hold valuable metalliferous lodes.

That part of the Quebec group which, in Canada, is rich in the more valuable metals is the middle division, composed of dolomites, diorites, and serpentines, such as those shown to extend, with a considerable breadth, for a distance of seventy miles on the east side of the northern peninsula; and in this connection it may be remarked that without having had an opportunity to thoroughly trace the structure in the localities where they occur farther east, similar rocks were observed in several places on the coast between White Bay and Cape St. John. One of these is Little Bay or Baie Verte, where serpentine rocks are pretty largely developed towards the head of the bay, in the neighbourhood of the Terra Nova mine. Another is Ming's Bight, 4 or 5 miles to the eastward, where rocks of the same kind rise in a high hill-range, keeping the east coast of the bay, and striking inland in a south-western direction. Associated with the serpentines in this neighbourhood, there are bands of anorthosite rock, diorite, dolomite, and a calcareo-magnesian rock stained green with oxyd of chro-

mium; and at Terra Nova mine the series was found to rest upon blackish or brownish finely-laminated talcoid slate. These rocks are in some parts marked with chromic iron, and in many with the sulphurets of iron and copper, occasionally in quantities economically available. Beneath the whole in Little Bay, a great mass of mica-slates strikes inland in a south-westerly direction from Coachman's Cove. They run up into the hills of the peninsula which divides Little Bay from White Bay, and may correspond with the mica-slates of the Western Arm already described. Near the central part of the peninsula between Little Bay and Ming's Bight, a considerable breadth of granitic rock occurs. It does not give much indication of gneissoid structure, but has a north-east and south-west trend, parallel with the other rocks on either side, and with the gneiss and mica-slate of the peninsula to the west, and may belong to the Laurentian series. From the distribution of the rocks in these two peninsulas, it would seem probable that there runs longitudinally through each of them an anticlinal axis, and that rocks of the middle division of the Quebec group are arranged in a synclinal form in each of the bays, in which they rest on the Laurentian series, without the interposition of the lower division, or of the Potsdam group.

Serpentines are also represented, or known, at Tilt Cove and Round Harbour on the peninsula, which terminates at Cape St. John, and farther south, rocks, which are probably of the same series, are exhibited on the islands of Hall's Bay, and again at Twillingate. In each of the latter cases they appear to be related to a considerable volume of limestone; but all this section of country requires a great amount of careful examination before any detailed descriptions can be entered upon.

Mention has already been made of the presence of copper ore in this middle division of the Quebec group, at How Harbour, Goose Cove, and the western side of St. Julien Bay; and although the quantities observed were not in any of these instances great, they yet serve to show that the ores of the metal accompany these deposits in their distribution, in Newfoundland as well as in Canada, and render it reasonable to expect the discovery of available quantities in those parts of the country hereafter. This is still further confirmed by their occurrence in the rocks of the middle division, on both sides of Little Bay, and in considerable

quantity at the head of the bay, in Terra Nova mine, and by indications observed on the west side of Ming's Bight; in several places in the vicinity of Twillingate, and on Sunday-Cove Island at the entrance of Hall's Bay. At Tilt Cove and Round Harbour copper ores are reported to be largely exhibited; but the plan of my exploration did not afford me time to visit these localities. Their value, however, has been made known by the enterprise of Mr. C. F. Bennett, of St. John's, who has obtained from the Government of the colony an exclusive right to the minerals over a very extensive tract of the country, and has entered upon mining operations at Tilt Cove, with a fair promise of a profitable return.

Iron pyrites was found to accompany the copper pyrites in most of the localities in which the latter occurred, but it was often met with disseminated in the rocks by itself, particularly in the black slates of the lower division of the Quebec group, where occasionally, as at How Harbour, it seemed almost sufficient in quantity to be made available for practical purposes. The largest deposit of it, however, that came under my observation was in association with the serpentine of the middle division at the Terra Nova mine, which has been opened with the intention of working it for exportation to England. The Terra Nova mine is situated at the junction of two streams, whose united waters, flowing north-easterly for about a mile and a quarter, fall into the upper extremity of Little Bay. The deposit upon which the mine has been opened appears to be a stratified mass of iron and copper pyrites, with intercalations of hard clay slates, and it is interposed between a considerable volume of serpentine on the one side and chloritic slate on the other. The metalliferous band has a considerable breadth—probably 30 feet, or even more—and within that width there are strata of solid or nearly solid iron pyrites, of from 4 to 5 feet thick. The general dip is about S. 80° E. $< 80°$. The upper part of it is chiefly iron pyrites, some of which is strongly magnetic; but in the lower part, the yellow sulphuret of copper is pretty generally disseminated, in combination with that of iron, and in some spots in considerable proportion.

When first discovered, the exposure presented a mass of ore projecting along the bottom of the main stream, from the point of land separating the north-west and south-west brooks; but the channels of both these brooks having been changed, near their

junction, for the convenience of mining, the waters of the north-west brook alone now flow over it. To prove the mine, five shafts have been sunk, numbered from 1 to 5, in the order in which they were excavated. Two of these are upon the metalliferous band, while the other three, so far as they go, have been excavated in the rock of the country. The strike of the mineral mass naturally exposed is about N. 20° E. and S. 20° W. true (the magnetical variation being about N. 35° W.). A short distance from the natural junction of the two brooks, in what appeared to be the run of the metalliferous band, No. 1 shaft was sunk in hard clay-slate without striking the band. No. 2 shaft was then sunk on the left bank of the main stream, in what appeared to be the run of the band northward. It was carried to a depth of 12 fathoms, through serpentine, without reaching the metalliferous band. From the bottom of this shaft a drift was carried in a south-eastward direction a distance of between 70 and 100 feet through serpentine all the way, passing beneath the main stream. Another shaft, No. 3, was then sunk to a depth of 8 fathoms, about 4 chains from No. 2, in the bearing N. 80° E. This is also through serpentine, which was found to be cut by numerous veins of calc-spar, with frequent specks of copper pyrites, and small masses of native copper. No. 4 shaft is sunk on the metalliferous band close by the natural junction of the two brooks. At the time of my visit it had been excavated to a depth of 20 fathoms; from this a gallery had been driven along the band, northward, for about 100 feet in the strike, at a depth of 10 fathoms, and another from the bottom of the shaft, in the same direction for the same distance. Both these galleries pass under the north-west brook. At the termination of each of them there appears to be a twist in the stratification. No. 5 shaft, called also Bell's Shaft, is situated about a chain from No. 2, in the bearing S. 55° W. In it the metalliferous band was struck at the depth of 10 fathoms. It is said that from the neighbourhood of No. 4 shaft the band separates into two branches going southward, and it is supposed that the reason why No. 1 shaft missed the band is that the shaft is sunk in the rock between these two branches. The whole circumstances of the case induce me to think that we have here a short sharp twist, or overlap, in the stratification, and that the band will run more regularly southward from the eastward of the two branches,

into which it appears to be divided at the junction of the streams, and more regularly northward from No. 5 shaft, in the general strike of the serpentine and the other rocks associated with it.

The investigations made by Dr. T. Sterry Hunt, the chemist and mineralogist of the Geological Survey of Canada, have shown that traces of chromium and nickel appear to be almost universally diffused in the serpentines of the Quebec group in Canada, and in the United States; and analyses made by him of several specimens from Pistolet Bay and Little Bay indicate that the serpentines of Newfoundland will not be an exception. It is, therefore, reasonable to expect the occurrence of these metals in available quantities in the island. The ore in which the chromium of commerce usually occurs is in combination with iron, and chromic iron has been obtained in Canada, in several places, in economic quantity. Although this ore was met with in Little Bay, the quantity was confined to mere crystals in the rock, but it strengthens the expectation of finding it in more abundance in other parts.

Serpentine is a rock capable of receiving a high polish, and it is extensively used in commerce for architectural purposes of a decorative character; and for such purposes any amount of it might be obtained in How Harbour, Little Bay, Ming's Bight, or wherever else it has been reported.

4. *Upper Silurian Series.*

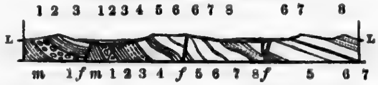
Proceeding southward along the coast of White Bay from Coney Arm Head, which, as has already been stated, is composed of coarse quartzose mica-slate, possibly of Laurentian age, there accumulates on these mica-slates a series of rocks traceable to Jackson's Arm. Jackson's Arm runs into the land, nearly at right angles to the strike; and here these upper rocks have a transverse breadth of about 2 miles. The following section of them, in ascending order, from the mica-slates, on which they are seen to rest, is taken from the north side of the arm, on which the measures appear to be broken by three considerable faults, causing what are supposed to be modified repetitions of some of the masses.

	Feet.
1. Coarse conglomerates, with a light grey arenaceo-micaceous slaty matrix, which is slightly calcareous. The masses enclosed consist of pebbles and boulders of gneiss, large rounded fragments of whitish or light grey mica-slate, some of a darker grey greenstone, reddish-grey quartzites, and occasional smaller masses of limestone; among these there is a good deal of finer material of the same character, slightly calcareous, and mica-schist runs in irregular flakes and patches in the general direction of the stratification, but its cleavage often partially conforms to the rounded surface of the boulders and pebbles. The beds are very massive, and they appear to be divided by grey micaceous schist	400
2. Sea-green slates, occasionally interstratified with dark grey, or blackish fine silky surfaced slates, some of which are harder than others	300
3. Grey, coarse, rough arenaceo-micaceous schist, frequently passing into fine conglomerate, with pebbles similar in mineral character to those of the coarse conglomerates beneath, but none of them exceeding the size of a hen's egg; the pebbles are sometimes arranged in regular layers, parallel to the stratification; bands of dark grey clay slate are occasionally interstratified in the mass	400
4. Grey micaceous and arenaceous slates	250
5. Green and black slates at the base, succeeded by grey arenaceous slate, which is interstratified with thin bands of sandstone ..	650
6. Green, bluish, and blackish slates, interstratified with grey flaggy sandstones; the slates enclose nodules of pinkish calc-spar, and veins of the same cut the strata	250
7. Greyish-blue limestone in a single bed	7
8. Grey calcareo-arenaceous slates, interstratified with greyish sandstones, with a heavy mass of grey white-weathering sandstone at the top	543
	2800

The above section can only be considered as giving an approximation to the truth. The three faults which dislocate the rocks, and are all considered to be upthrows on the east side, render it difficult to follow the sequence with exactitude; and some of the masses, which are supposed to be in a general way equivalent, on opposite sides of the faults, appear in different parts to be modified in volume, and somewhat in lithological character, by different degrees of metamorphic action. The most western of the faults occurs in a small cove, upwards of half a mile from the upper end of the arm. It seems to be an upthrow of probably 1000 feet, and by it the coarse conglomerates 1, which rest upon the mica-slate

at the upper end of the arm, are repeated on the other side of the cove. The fault appears to be coincident with a vein or dyke of granitoid rock, of which several occur, though they do not in every case greatly dislocate the measures. They are uniform in appearance; the rock weathers yellow, but when fresh broken has

SECTION, JACKSON'S ARM.



Horizontal and vertical scale, a mile to an inch.

m. Mica slate.
1. Coarse conglomerates.
2. Sea-green slates.
3. Slates and fine conglomerates.
4. Micaceo-arenaceous slates.
5. Black and green slates.
6. Green, bluish, and black slates.
7. Blue limestone.
8. Slates and sandstones.

L. Sea level.

f, f, f. Faults.

a pale, yellowish-pink colour; it is very fine grained, and has a conchoidal fracture. Some of the veins or dykes run with the strata, and others intersect them, and they vary in thickness from 1 to 30 feet. They are cut by white quartz veins, which are confined to them, and do not run into the strata on each side. The second fault occurs upwards of 2 miles from the upper end of the arm, where the coast suddenly runs northward for about half a mile, into a pretty deep cove. This fault does not seem to dislocate the measures more than 200 feet. The third fault occurs in the inhabited cove, about 400 yards from the outside point of the arm. It is supposed to be a dislocation of perhaps 1200 feet. On the west side of it, and of the cove, there is an abrupt low hill, formed of strong massive beds of quartzite, some of which appear to have a slaty cleavage; they are supposed to belong to the summit of the section, but would give a much greater volume to this part of it than the amount stated. On the east side of the cove there is a pale, pinkish-white, splintery feldspathic rock, of which the relation to the others is not well understood; but it appears to be connected with the slates and sandstones of division 6, or to be intrusive. In addition to the granitoid, compact, fine-grained veins or dykes, there are others in the upper part of the arm, which consist of a brown splintery, apparently feldspathic rock, which, like them, run in some places with the stratification, and in others oblique to it.

These rocks run along the coast to the southward of Jackson's Arm, and extend to the upper end of Sop's Arm. As well as the coast, they form Sop Island and Goat Island, which is inside of it; and from their limit in Sop's Arm to the outside of the former island, they have a transverse breadth of upwards of 5 miles. In this neighbourhood they seem to be even more dislocated, contorted, and disturbed than they are in Jackson's Arm, and much more altered. Their general identity, however, is sufficiently evident. At the upper end of Sop Island, on the west side, the strata are, in general, very highly tilted, often quite vertical, with a strike about S.S.W., and they consist of slates, quartzites, and conglomerates, the enclosed masses in the last being quartz, slate, greenstone, and red feldspar, with a few scattered fragments of blood-red jasper. One band of rock has the aspect of a conglomerate which has been fused into a solid mass, in which the paste and enclosed fragments are so melted into one another as to make it difficult to define their respective limits. The slates, as at Jackson's Arm, are speckled with nodules, patches, and short veins of pink calc-spar, and the strata are intersected by veins or dykes of pale yellowish-red or pink feldspathic rock, weathering to a faint sulphur-yellow. In these, small cubes of iron pyrites are abundant, and the felsite is cut by veins of quartz, which do not penetrate the rock on either side. From the northern extremity of the island, what appears to be a great porphyritic dyke, runs through it in the general strike of the stratification, and enters upon the south side of Sop's Arm, at a promontory, which is nearly 2 miles eastward of Spear Point. The dyke consists of reddish felsite, enclosing feldspar crystals of a pale flesh-red, with a yellow tinge. On the surface it has a granitoid aspect, and its colour is a light dull amber-brown, blotched with pale reddish, yellowish, and whitish spots. Where it leaves the island on the south side, the rock has a transverse columnar structure; in it are disseminated many small crystals or grains of transparent or translucent quartz, and occasionally many small cubes of iron pyrites. At the upper end of the island, on the east side, the dyke is lined with a mass of pale yellowish-pink felsite, weathering yellowish, making the relation of the great dyke and of the small one, already mentioned, sufficiently evident. In this part, the dyke has a breadth of about a quarter of a mile, and in mid-length of the island it apparently

swells to a greater width, and comes out on the south side somewhat narrower than it is at the northern extremity, but accompanied on the west side by altered conglomerates, which it is sometimes difficult to distinguish from it.

At the upper end of Sop's Arm, there appears to be another mass of felsite porphyry, which, with a difference in colour, has much the same character as the dyke of Sop Island. It is in general of a reddish or purplish grey, with pale flesh-red and white grains of feldspar. The rock is intersected by innumerable white quartz veins, some of them pretty large, and some of them showing small quantities of specular iron ore. The mass forms a low range of bare hills across the extremity of a promontory, between two pretty deep coves in the northern part of the east end of the arm. The strike of the mass is about S. 30°–40° W., and there is more of the same kind of rock farther southward, in the point west of the brook which falls into the southern cove in this part of Sop's Arm. On the west side of the rock there are grass-green slates, which appear to be of a chloritic character, and they are mottled and irregularly marked with pea-green epidote; but on the east it is followed by what are considered to be altered conglomerates, in which, however, the enclosed masses, some of which are very large, and other parts are seemingly so fused into one another, while the matrix so closely resembles the felsite of the porphyry, that it is really very difficult to say whether both the rocks should be classed as porphyries, or altered conglomerates, or the one be distinguished by a different name from the other.

Between the conglomerates of Sop Island and those of the eastern end of Sop's Arm, the rocks of the western part of Sop Island, of Goat Island, and of the main coast, appear to be slates of various shades of green, often marked by pink calc-spar in nodules, patches, and short veins; of occasional interstratified sandstones, sometimes fit for flagging, with calcareo-arenaceous bands; and occasional impure limestones, weathering brownish. East of Bartlet's Cove, which is an indentation on the south side of the south-western extremity of Sop Island, there was seen a thickness of 50 feet of black slates. These rocks are, in several places, characterised by fossils, which are somewhat obscure; but though few of them could be specifically determined, they have yet, according to Mr. Billings, a general aspect allied to that of

Upper Silurian types. It would, however, for the present, be impossible to say to what horizon in the series the different divisions of the rocks of Jackson's Arm and of Sop's Arm may belong; and it may be proper to remark, that while no doubt is entertained of the general equivalency of the rocks of the two localities, all the places in which organic remains were observed, occur in the neighbourhood of Sop's Arm.

One of these localities is Bartlet's Cove. Here the fossils occur in calcareo-arenaceous flagstones, and the genera observed, in addition to numerous fucoids and crinoidal stems were a *Murchisonia*, an *Orthoceras*, and a *Graptolithus*. At a point on the main coast, half-way between Spear Point and the promontory occupied by the porphyry, which strikes from Sop Island, organic remains were met with in strata somewhat similar to those of Bartlet's Cove; they consisted of fucoids, crinoidal stems, and an *Orthoceras*. On the western side of Goat Island, still in the same description of strata, in addition to fragments of crinoidal columns, there were met with a *Syringopora*, and *Favosites Gothlandica*. Many of the specimens of coral were here replaced by white, and, in some instances, by pink calc-spar.

The rocks of Sop Island, Goat Island, and Sop's Arm, and the neighbouring main coast, are intersected by many veins of white quartz, some of which contain specular iron ore, generally in small quantities, and others the yellow sulphuret of copper. One of the former is seen associated with the porphyroid rock described, at the east end of Sop's Arm. It presents druses, lined with six-sided terminated prisms of transparent and translucent quartz, and these are in many places invested with steel-grey specular iron ore, and in others with minute scales of red hematite. A vein of a similar character intersects green slates at the south side of the arm, about 2 miles from the upper end; a probable continuation of it, still in green slates, runs, parallel with the strike, through the eastern end of Goat Island, and is probably still continued across a point on the coast about 2 miles farther northward. Another occurs on Sop Island, on the opposite side of the narrows between it and Goat Island. In this are enclosed masses of bluish-green chlorite, which is penetrated by projecting prisms of transparent quartz; and peroxyd of iron, in steel-grey and red scales, is disseminated in small quantities in the vein. In

Bartlet's Cove a somewhat similar white quartz vein occurs, which was marked by the presence of copper pyrites, sparingly disseminated; but on the east side of Sop Island, about a mile from the north end, there appears to be a fault or dislocation, constituting a lode, in which the yellow sulphuret of copper occurs in more abundance. The bearing of the lode is S. 56° W., and the mass between the walls is made up of crushed and broken fragments of the rock on either side, which belongs to the porphyritic dyke running through the island, with fragments of slate. The width of the lode varies from a few inches to a foot, and throughout this the yellow sulphuret is abundantly disseminated in small grains. It also appears to penetrate, in a smaller degree, the walls on either side of the lode, which are much stained by green carbonate. An average sample of the lode, however, has yielded to analysis only one per cent. of metallic copper.

The limestones of the formation appear in general to be too impure for burning into quicklime, but there are several bands of the rock which might be very well adapted for building, and occasionally a good coarse sample of whetstone may be procured from slaty portions of the formation.

The eastern limit of the formation appears to run into the cove on the west side of Spear Point, where it is succeeded by rocks supposed to belong to a higher formation. The general dip of the strata is to the south-eastward, across the whole breadth; but the occurrence of the conglomerates on each side suggests that it may be arranged in the form of a trough between the parallel belts of porphyry, with an overturn on the south-east side. It seems probable, however, that the rise of the conglomerates on this side, perhaps occasioned by the intrusion of the porphyry, is only to be considered an undulation subordinate to a wider trough lying in White Bay.

5. *Devonian Series.*

In describing the dislocation which crosses Croc Harbour, mention was made of the peninsulas of Cape Rouge and Cape Fox. These peninsulas are joined to the main coast by very narrow necks of land, and between the peninsulas is situated Cape Rouge Harbour. Both peninsulas are composed of the same rocks, the strata striking across the harbour, from the one to the other, in a

general N.N.E. and S.S.W. bearing. The Cape Rouge peninsula, on the northern side of the harbour, gives the larger development of these rocks, and the coast along this part of the harbour was selected to obtain a section. The direct breadth across the measures, from the neck of the peninsula to the Atlantic on the outside, is just about 2 miles; but in this the strata are arranged in the form of a trough, with the dislocation, which has already been alluded to, running through it, nearly on the strike, at one-third of the breadth from the neck of the peninsula; and towards this dislocation the strata dip in opposite directions, at angles varying from 34° to 51°. A greater volume of strata crops out on the south-eastward side of the trough than on the north-westward; and as those at the base, on the latter side, do not make their re-appearance on the other, it is concluded that the dislocation is a downthrow on the south-eastern side, equal in amount to at least the difference in volume between the two. The base of the strata on the north-western side, approaches the diorites and quartzites of the middle division of the Quebec group, and it is supposed to rest upon them unconformably: the following is a description of the series in ascending order:—

		Feet.
1.	Coarse conglomerates, of which the paste is a greenish-grey micaceous sand, and the enclosed pebbles consist chiefly of reddish-grey diorite, opaque white quartz, bluish quartzite, and occasional red jasper. The conglomerates are in massive beds, and are interstratified with greenish-grey micaceous sandstones	93
2.	Greenish-grey micaceous sandstones, with ripple-mark on some of the surfaces, and occasional carbonised broken remains of plants	8
3.	Coarse conglomerates, as before	18
4.	Measures concealed	40
5.	Black slates interstratified with thin beds of hard grey sandstone, followed by reddish slates at the top	15
6.	Coarse conglomerates, as before in massive beds, interstratified with greyish slate bands	29
7.	Measures concealed	60
8.	Reddish slaty micaceous sandstones, becoming blackish grey at the top; the surfaces of the beds show coarse ripple mark ..	11
9.	Measures concealed	29
10.	Dark grey dolomite in thin beds, some of which weather yellow; the surfaces of some of the beds are occasionally marked with reticulating crack-casts	37
		340

These strata occur in the isthmus joining the peninsula of Cape Rouge with the mainland, and from the isthmus, the coast of the peninsula and the strike so nearly coincide for upwards of a mile, that no additional strata can, for that distance, be safely gathered from it. Between this point and the fault, however, the shore becomes obliquely transverse to the measures. The direct breadth across them is about a quarter of a mile, and the average slope of the strata thirty-four degrees, which would give a thickness of about 750 feet. This consists of red and black slates interstratified with greenish-grey sandstones.

The section on the opposite side of the fault occupies the coast to the outside of the harbour, and gives the following strata in descending order:—

	Feet.
1. Red, green, and black slates, with a mass of greenish-grey sandstone at the top	650
2. Measures concealed in a valley, having a breadth of about 30 chains	1000 ?
3. Red slates with bands of red and green sandstone	1450
4. Red, black, and green slates interstratified with sandstones, and yellow-weathering bands, probably dolomites	450
	3550

The transverse breadth of the section is about 90 chains; the inclination near the fault is 36°, which gradually increases and becomes 51° on the outside of the harbour. This would give about the same vertical thickness, in which, however, it is taken for granted that the strata concealed under the valley (2) are not affected by any undulation or dislocation. It would appear from this that, with the conglomerates at the base, the whole thickness would be about 3750 feet, and that the fault may be considered a displacement of about 2500 feet.

Groais Island lies eastward from Cape Rouge about 9 miles. The north end, and probably the whole island, consists of coarse quartzose mica-slate, like that of Coney Arm Head, and it is cut by white quartz veins carrying small quantities of copper pyrites. At the north-west corner, cliffs of the mica-slate rise vertically up from the water for 350 feet, and the dip appears to be N. 35°–45° W. $<$ 37°–45°. The small island north of this corner consists of strata belonging to the series displayed at Cape Rouge Harbour. They appear to unconformably overlie the mica-slate of Groais,

their dip being S. 80° W. $<$ 18°, and they consist at the base, in a cliff in which they are seen, of coarse conglomerates, with enclosed masses of the mica-slate in an arenaceous paste. The conglomerates are surmounted by about 70 feet of red and grey sandstones and red slates, which are capped by about 30 feet of conglomerates interstratified with green arenaceous shales, and the surfaces of some of the sandstones display carbonised comminuted plants.

On submitting to Dr. J. W. Dawson (of McGill College, Montreal, so well known for his great skill in fossil botany) the plants belonging to this formation obtained here and at Cape Rouge Harbour, he has favoured me with the succeeding remarks. "Though all the specimens are obscure, there seem to be among them the following forms: 1. *Psilophyton*, like *P. princeps*; 2. *Lepidodendron*, decorticated, resembling *L. Chemungense*; 3. *Sigillaria*, a small portion of a stem not specifically determinable; 4. Striated stems, probably stipes of ferns; 5. *Sphenopteris*, a small and obscure leaflet. The supposed fossil wood and carbonaceous matter show no structure. Though the collection does not afford sufficient material to warrant a decided opinion, I should be inclined to refer it to the Upper Devonian, rather than to any other period."

The formation would thus appear to be equivalent to a part of what, in the 'Geology of Canada,' have been called the Gaspé sandstones. The rocks under description certainly bear a strong general resemblance to a portion of this group, but they also in some degree resemble the Bonaventure formation of Gaspé, equivalent to the Lower Carboniferous of Nova Scotia. Until more definite evidence is obtained, however, it will be convenient to class them provisionally as belonging to the Devonian series.

From the Gaspé sandstones at the eastern extremity of Canada petroleum springs issue in many places; and as it is from the Devonian series that petroleum is obtained in such abundance in Pennsylvania and in Western Canada, it seems reasonable to expect that available quantities of the substance will reward researches in Gaspé. No springs of petroleum were observed in the vicinity of Cape Rouge Harbour; but concentric nodules of irregular, and sometimes elongated forms, were occasionally met with in black, hard, argillaceous slates towards the base of the formation, which

on fracture were found to be charged with the oil, and the fact is one not to be lost sight of.

In the deep cove west of Spear Point, in White Bay, red, green, and black slates strike into the land, a short distance east of one of the points mentioned as giving fossils allied to Upper Silurian types; and it seems probable that we have here the junction of the Upper Silurian and Devonian series. Similar red, green, and black slates form the west side of White Bay, from Spear Point to the entrance of Salt Water Pond,* on both sides of which conglomerates occur, and contorted red and green slates, with grey sandstones and conglomerates, continue on the west side of the bay, on the way to Gold Cove at its head. From the lithological character of these rocks, and the geographical relations they bear to the Upper Silurian near Spear Point, it is assumed that they are contemporaneous with those of Cape Rouge and belong to the Devonian series; but as the few fossils that were obtained are too obscure to be in any way identified, the most satisfactory evidence is still wanting. The disturbances of this part are very great, the strata being frequently dislocated by considerable faults, and frequently inverted or much contorted; so that to follow out the structure minutely would be a labour requiring much more time than I felt to be at my disposal. The general arrangement, however, exclusive of minor complications, seems to show that the formation here lies in a sharp narrow trough, supported by the Upper Silurian series, keeping the west side of White Bay to its head, and then including Northern Island. Farther inland, to the southward, the trough may lose its sharpness, and spread out in the valley of River Head Brook.

The presence of small quantities of carbonaceous matter, occurring occasionally in the rocks at Cape Rouge, has given rise to rumours of the existence of coal seams there, and in other localities in the neighbourhood, where the formation is exposed. One thin exceptional seam of coal is known to occur in the equivalent rocks of Gaspé.† Its thickness does not exceed 1 inch, and it is the only one which has been detected in a thickness of strata exceeding 7000 feet, belonging to the forma-

* This is another Salt Water Pond having no relation to that previously mentioned.
† 'Geology of Canada,' p. 394.

tion, which are nearly all exposed on the Gaspé coast of the Gulf of St. Lawrence. The formation is beneath the horizon of that series of rocks which, from the presence of workable coal seams in it, is truly called the Carboniferous, and nothing that we know of this lower formation elsewhere in America, or that I have observed on the coast of the northern peninsula of Newfoundland, would justify the expectation of discovering in it coal beds of any commercial importance.

On the north-west coast of Hall's Bay there occurs a conglomerate chiefly of a red colour, with interstratified beds of grey and red sandstone. Similar rocks are partially exposed, resting on syenite, on the south-east side, towards the head of the bay. They form also the islands at the entrance to Indian Brook, and both sides of the brook as far as we ascended. These strata are usually only slightly tilted, while other apparently older rocks come up at intervals, considerably disturbed; but a great accumulation of drift, which is extensively spread over the valley of the stream, generally conceals the older rocks, and the junction of the two was nowhere observed. There is little doubt, however, that the conglomerate rests upon the disturbed rocks, unconformably, and it may possibly be of a later age than the Devonian; but the absence of fossils, without further evidence, must leave the matter in suspense. Small specimens of coal, which have been found near the upper rock in Hall's Bay, are no evidence of any weight on the point, as these are clearly a part of the ancient drift, and may have been derived from Carboniferous rocks farther north.

6. *Superficial Drift.*

Superficial deposits, on the great northern peninsula of Newfoundland, may be said to have no existence, except in the shape of great erratic blocks, with which the country generally, and the valleys particularly, are covered; nearly the whole of the finer material having been swept into the sea. The surfaces of the rocks are often smoothly rounded, and they sometimes exhibit the parallel grooves and scratches of glacial action. In Beaver Cove of Canada Bay, and at the exit of this bay, they were observed bearing S. 25° E., which is just about the bearing of the valley, from the head of Long Arm to the exit of the bay. The

most northern drift deposit of any consequence that was met with, was at the head of Little Bay, near the Terra Nova mine, where there is a thickness of probably 50 or 60 feet of stratified clay, gravel, and sand, containing modern marine shells, at the height of about 40 feet above the high-water mark. The surfaces of the rocks next the shore are here sometimes smoothly rounded and marked by parallel scratches. The bearing of the grooves is S. 56° W., which is the general bearing of the valley. Farther south, the drift becomes more important, and it extends over a large area north-west of Hall's Bay, and up the valley of Indian Brook. The banks of this stream expose high sections of stratified clay, which is sometimes of a reddish, and sometimes of a drab or bluish colour. It is usually surmounted by beds of sand or gravel, or an admixture of the two, and it gives, in many instances, a considerable extent of flat or gently undulating country, thickly covered by forest trees, such as white pine, balsam, fir, poplar, and birch, some of which are often of large size. Considerable tracts through this part of the country seem to possess the ordinary requirements of agriculture, and would be eligible for settlement. The clays appear to be suitable for the manufacture of bricks, and the timber, in many places, is sufficiently abundant for the construction of dwelling-houses, and such-like purposes.

I have the honour to be, Sir,

Your most obedient servant,

A. MURRAY.

APPENDIX.

LOWER SILURIAN ROCKS OF NORTH AMERICA.

As the Lower Silurian rocks will probably form a prominent feature in the geology of Newfoundland, it may be useful to state here the succession of deposits which constitute the series, according to our present knowledge. The sediments which in the first part of the Silurian period were deposited in the ocean surrounding the Laurentian and Huronian nucleus of the present American continent, appear to have differed considerably in

different areas. Oscillations in this ancient land permitted to be spread over its surface, when at times submerged, that series of apparently conformable deposits which constitute the New York system, ranging from the Potsdam to the Hudson River formation. But between the Potsdam and Chazy periods a sudden continental elevation, and subsequent gradual subsidence, allowed the accumulation of a great series of intermediate deposits, which are displayed in the Green Mountains, on one side of the ancient nucleus, and in the metalliferous rocks of Lake Superior, on the other, but which are necessarily absent in the intermediate region of New York and Central Canada.

At an early date in the Silurian period, a great dislocation commenced along the south-eastern line of the ancient gneissic continent, which gave rise to the division that now forms the western and eastern basins. The western basin includes those strata which extended over the surface of the submerged continent, together with the pre-Chazy rocks of Lake Superior, while the Lower Silurian rocks of the eastern basin present only the pre-Chazy formations, unconformably overlaid, in parts, by Upper Silurian and Devonian rocks. The group between the Potsdam and Chazy, in the eastern basin, has been separated into three divisions, but these subdivisions have not yet been defined in the western basin. In the western basin the measures are comparatively flat and undisturbed; while in the eastern they are thrown into innumerable undulations, a vast majority of which present anticlinal forms overturned on the north-western side. The general sinuous north-east and south-west axis of these undulations is parallel with the great dislocation of the St. Lawrence, and the undulations themselves are a part of those belonging to the Appalachian chain of mountains. It is in the western basin that we must look for the more regular succession of the Silurian rocks, from the time of the Chazy, and in the eastern, including Newfoundland, for that of those anterior to it. It is to be remarked, however, that in the great northern peninsula of Newfoundland, instead of undulations, great lines of fracture and dislocation are observed, while the strata are but little tilted, and it has not been decided precisely where the limit between the eastern and western basins is to be found in that island. It seems probable, however, that it will run on the east side of the

Laurentian mountains, which form the backbone of the peninsula just mentioned.

The succession of Lower Silurian formations in North America may be thus tabulated, the palæontological evidence as to the relations of the Upper Calciferous and the Quebec group to the formations above and below them, having been determined by Mr. Billings.

English Synonyms.	Complete Series.	Western Basin.	Eastern Basin.	Newfoundland.
Caradoc ..	12. Hudson River ..	Hudson River	..	..
	11. Utica	Utica	..	..
	10. Trenton group ..	Trenton group	..	..
Caradoc? ..	9. Chazy	Chazy	..	..
Llandeilo ..	8. Sillery (Quebec group)	..	Sillery	Sillery
	7. Lauzon (Quebec group)	..	Lauzon ..	Lauzon
	6. Levis (Quebec group)	..	Levis	Levis
	5. Upper Calciferous	..	..	U. Calciferous
Tremadoc ..	4. Lower Calciferous	L. Calciferous	..	L. Calciferous
	3. Upper Potsdam	U. Potsdam	..	U. Potsdam
Lingula flags	2. Lower Potsdam	L. Potsdam?	L. Potsdam	L. Potsdam
	1. St. John's group	..	St. John gr.	St. John's gr.

It thus appears that the lower portion of the series is complete in Newfoundland, and the upper in New York and Central Canada. Divisions 3, 4, and 5 have not yet been recognised in the eastern continental region.

The St. John's group, 1, is represented at St. John, New Brunswick, by 3000 feet of black slates and sandstones, whose fauna, described by Mr. Hartt, was correctly referred by him to Étage C of Barrande's primordial zone. It there reposes on older schistose rocks, as yet unstudied, but by Messrs. Hartt and Matthews designated as Cambrian. The slates of St. John, New Brunswick, Newfoundland, and the Paradoxides beds of Braintree, Massachusetts, also probably belong to the same horizon.

The Lower Potsdam, 2, is represented by several hundred feet of limestones and sandstones on the Straits of Belleisle, and on White Bay, in Newfoundland, and by the slates of St. Albans and Georgia, Vermont.

The Upper Potsdam, 3, is that of Wisconsin and Minnesota, represented in the typical Potsdam of New York, which is overlaid by the Lower Calciferous, 4; while the Upper Calciferous, 5, is only recognised in the northern peninsula of Newfoundland.

The Quebec group, 6, 7, 8, is divided into three parts, named from localities where they are largely displayed. The first or Levis division embraces the limestones and black slates of Point Lévis, Orleans Island, and Phillipsburgh, with their numerous fauna of trilobites and graptolites, for the most part identical with those of the Skiddaw slates. The second or Lauzon division was at first united with the preceding, but has been separated from it on account of its great mineralogical importance and distinctness, it being the metalliferous zone of the Lower Silurian in North America. Magnesian rocks, including dolomites, magnesites, serpentines, diorites, chloritic and steatitic beds, with micaceous and gneissic strata, characterise this Lauzon division; which is, moreover, rich in copper ores, chiefly as interstratified cupriferous slates, and is accompanied by silver, gold, nickel, and chromium ores. The only fossils certainly recognised in it are an *Obollela* and two species of *Lingula*, at its summit. It is overlaid by the Sillery division, which consists of a great mass of sandstones and conglomerates, 2000 feet thick, interstratified with red and green slates, and, so far as yet known, is destitute of fossils. In a large part of its distribution, the Quebec group is crystalline and metamorphic, but the characteristic mineral elements of the Lauzon division are to be found both in the altered and unaltered portions.

W. E. L.

CHAPTER III.

REPORT FOR 1865; BEING A NARRATIVE OF EXPLORATION FROM THE EASTERN TO THE WESTERN SHORES OF THE ISLAND, BY THE VALLEY OF THE INDIAN BROOK, HALL'S BAY; AND THENCE BY THE GRAND POND AND TRIBUTARIES TO ST. GEORGE'S BAY.

ST. JOHN'S, NEWFOUNDLAND,
24th January, 1866.

MAY IT PLEASE YOUR EXCELLENCY,—

Although not prepared to send in a formal report of my proceedings in connection with the geological investigation of this province, with which I have been entrusted, I feel it my duty to represent the manner in which I have been engaged during the past season, while prosecuting that investigation for the information of the Government and Legislature.

My reports, as you are aware, must in regular course pass through Sir W. E. Logan, who acts as General Director; and, moreover, as my collection of fossils and minerals have all been forwarded to Montreal for examination and analysis, it will be evidently out of my power, previous to my return to Canada, to enter fully into particulars respecting the geology of the country, or to give more than a brief sketch of generalities, such as I have been able to discover in the field without other reference.

Before entering upon the subject of my late exploration, I hope I may be pardoned if I make a few remarks regarding the legitimate nature of a geological survey, properly so called—a subject on which I fear there is very great misapprehension on the part of many in this province. Practically, the first thing to be done is, to work out the relation, succession, and distribution of the different geological formations, each of which is more or less characterised by peculiarities, mineral and fossil. In order to do this it is essentially necessary to be provided with a topographical map, at least having some pretensions to accuracy, whereon to delineate the geological features; and when such cannot be procured, the

only alternative is to construct one—a matter requiring in itself no small amount of time, patience, and diligence.

The names given to the various geological formations, each of which represents an epoch in the earth's history, may appear to the uninitiated as pedantic or empirical; but some distinctive appellation is obviously necessary to make the matter intelligible, and those that are given are generally recognised and understood.

The importance of accurate geological inquiry, as a matter of science, is recognised by the civilised world at large; but independently of scientific results, such inquiry can only tend to develop the mineral resources of a country, by plainly exhibiting and illustrating the facts by maps, sections, and specimens. With these and a description of the details, the subject may be easily understood.

A geological map of a new country, accompanied by sections and well-arranged specimens, is perhaps the best advertisement that could be publicly given to induce the introduction of labour and capital; and to construct the former and judiciously arrange the latter is most especially the province of the geological surveyor. To illustrate what I am anxious to express, let us take the existence of coal as an example. That mineral, or one very nearly allied to it, is known to exist in other formations besides that of the Carboniferous, and even in some instances to occur in partially workable quantities; but as the great available beds of coal are especially peculiar to that age or formation in all parts of the world hitherto explored, little confidence would naturally be placed in haphazard statements of its existence in association with other rocks. The inquiries to be made by persons desirous of venturing on mineral speculation would consequently naturally be—Where does your coal exist? Of what extent is your coalfield? In what part of the formation is your seam or seams? What is the thickness? What is the mineral and fossil character of the associated rocks? &c. &c.—all of which can only be answered to the satisfaction of those conversant with the subject, in the way I have already stated, by *maps, sections,* and *specimens.*

Sir W. E. Logan has already informed your Excellency, through a letter I brought last spring addressed to the Hon. the Attorney-General, that I had sent him a map and report of my investiga-

tions during the year 1864. This report has not hitherto been submitted to the Government here, for sundry reasons, all of which can be readily explained.

When I returned to Montreal in December 1864, Sir William was in England, where he was unavoidably detained much longer than anticipated by matters connected with the geological survey of Canada.

Having previously arranged and examined my collection for the season, I followed him thither, and in April last delivered him the map and report already referred to, which, however, he deemed it prudent to withhold from publicity until he had an opportunity of personally inspecting the evidences corroborative of my statements; and further, he considered that it would be more judicious and less expensive, should it prove to be possible, to throw the subject of the two years' work into one report; by which procedure also there would be the advantage of additional experience, probably tending to modify, to some extent, first impressions.

As the local government authorities were kindly pleased to leave the method of exploration entirely to my own discretion, I have adopted the one agreed upon between my director and myself as the best, as far as has laid in my power—viz. to explore the northern part of the island first, by which means my observations can be connected with others made by Mr. Richardson, of the Canadian Survey, in 1862; and further, that by working in a southerly direction I should be gradually approaching a position where my operations would be less likely to be impeded, especially during the later months of the year, from the inclemency of the weather and other difficulties. The scheme of the last season was to examine the island from its eastern to its western shores, taking a line as far northwards as might prove to be sufficiently convenient; and this I have done by following the valley of the Indian Brook from Hall's Bay, and thence by the Grand Pond and its tributaries to St. George's Bay. Previous to starting on this expedition, however, I paid a visit to Tilt Cove, on the northern shore of the great bay of Notre Dame, where mining operations were already proceeding, and where I felt assured I should be able to instruct myself as to the mode in which the copper ores of the country might usually be expected to occur. In this idea I was by no means disappointed: I found the mineral deposits so well

illustrated there, by the nature of the ground and the work that had been done, that I considered it my duty to make an accurate survey of the place, a copy of which survey I have the honour to present to your Excellency with this document.

While in the neighbourhood of Tilt Cove I also took the opportunity of crossing over the peninsula from Shoe Cove to La Scie, in order to get a stratigraphical section of it, as well as my time and means would permit. Without entering into particulars as to the lithological character or stratigraphical arrangement (a matter I must defer until my collection of specimens have been more thoroughly examined), I may broadly state that the ore deposits of Tilt Cove occur under conditions strikingly similar to those known in Eastern Canada, and to characterise rocks of apparently contemporaneous origin. By reference to the plan it may be observed that the metallic material is arranged in isolated, irregularly shaped masses, through a set of strata conforming with beds, above and below, of a calcareo-magnesian quality, and that those beds are succeeded on the north by a great body of serpentine. As from all I have hitherto seen, and from all the information I have been able to gather, the copper will in this country most frequently be found to occur in a similar manner—that is to say, in *beds* rather than regular *veins* or *lodes*—I think it right to call particular attention to the facts of this case, and to express a strong opinion for the benefit of adventurers and explorers, that the immediate neighbourhood of the serpentinous rocks, wherever they may be found to exist, will be the most probable position for their labours being crowned with success. These serpentines, besides being associated with many valuable metallic substances, frequently afford a beautiful variety of marble, which in many cases of itself might prove of considerable importance; added to which may be enumerated the frequent occurrence of other reverberatory minerals, such as soapstone, potstone, asbestos, and talc. Chromic iron is frequently associated with the serpentine, and may probably be discovered in some parts in workable quantity; for the value and uses of which I beg to refer to the 'Geology of Canada,' pages 748, 749.

In passing from Tilt Cove to Hall's Bay, I took the opportunity of landing at one or two points, in order to gather such information regarding the structure of that part as my limited time would

permit. At Lush's Bight, on Long Island, I observed a band of limestone holding fossils, which if not too obscure for identification, may be found useful in throwing some light on that subject. These with the rest of my collection have been forwarded to Canada, for the inspection of Mr. Billings, the palæontologist of the Canadian Geological Survey.

In making my exploration across the island, I considered it a very necessary matter to make a topographical survey of the country passed through, as it soon became very obvious that the maps already published gave but the rudest idea of its physical geography, and were utterly valueless for the representation of geological detail. This survey was accomplished partly by scaling the rivers by compass bearings, the distances being measured by Rochon's micrometer telescope, and partly by connecting a system of triangles by theodolite, a further check being kept on all convenient occasions by ascertaining the latitude by astronomical observation. An estimate of the rise on the rivers was also made, and the heights of the principal mountains or hills ascertained either by triangulation or simultaneous observation of two pocket aneroid barometers. A plan of these observations was drawn in the field on a large scale, in order to obtain as near an approach to accuracy as possible, from which I have since constructed a map on a scale of four miles to one inch, a tracing of which I have now the honour to submit to your Excellency.

In resolving to cross the island by the line already indicated, I was to a considerable extent influenced by various rumours regarding the presence of coal in certain parts of the interior, and considered it a matter of the first importance to do my utmost to develop the extent and distribution of the formation, should it prove, as it has done, to exist. Although it was absolutely impossible for me to follow out the subject perfectly, and many modifications of the outlines made on the map may eventually be introduced, I nevertheless feel pretty well assured that these representations will be found on the whole tolerably correct.

Proceeding now to describe the country represented on the map, I shall begin, first, by giving a brief account of the geographical characteristics, and afterwards in a general way the geological distribution.

The Indian Brook, where the survey commenced, falls into

Hall's Bay, on the north side, in lat. 49° 31′ N., long. 56° 2′ W. The lower course bears upwards N. 42 W.,* with a distance a little over 2 miles in a straight line, at the termination of which there is a fall of 12·7 feet. From the falls a straight line bearing about S. 77° W., the distance a little over 12 miles, will strike the lower end of the Indian Ponds, found by observation to be in lat. 49° 28′ 41″ N. This course, however, keeps entirely to the north of the river, and the river itself being very tortuous in some parts, the whole distance followed up to the same point will be rather over 18 miles. A succession of three small lakes or ponds, connected by narrow channels where there is a slight current, then extend west-south-westerly for about 8 miles, above which the valley of the main river maintains a remarkably straight course, although the river itself meanders greatly, bearing S. 52° W. for a distance of between 8 and 9 miles, above which the stream makes a sweep to the northward, and finally terminates in some small sheets of water among the mountains.

The Indian Brook is supplied with numerous tributary streams for the whole length of its course, the largest of which, flowing rapidly and in a very straight southerly direction, falls into the upper Indian Pond, at a short distance from the junction of the main river. The main stream is for the most part rapid, but is nevertheless easily navigated by canoes or small boats when it is moderately well supplied with water, although, being very low at the time of our visit, we were obliged to drag our craft for about one-half of the distance. Except at the falls, where there is a portage of about 100 yards, there is no interruption to the navigation of the river, so far as it was followed. The estimate of the rise from high-water mark was as follows:—

From high-water mark in Hall's Bay to the foot of the falls, in current and rapids, about 5 feet.
The falls by measurement, 12·7 feet.
In a succession of rapids and currents to lower Indian P[illegible] feet.
Height of lower Indian Pond, 32·7 feet.
Height of upper Indian Pond, say 33 feet.
In rapids and currents from the upper Indian Pond to the portage at the watershed, 15 feet.
Height at the portage at watershed, say 48 feet.

* The bearings are from the true meridian.

The portage over the watershed runs in a S.S.W. course, over low barren land for about 4 miles, at the end of which it strikes the head of upper Birchy Pond, found to be in lat. 49° 21′ 9″. The height of upper Birchy Pond was assumed, by a rough estimate made of the rise and fall on the portage, to be about 50 feet. About a mile to the eastward of upper Birchy Pond there is another extensive sheet of water, which I have called Sheffield's Pond, lying about 135 feet higher than Birchy Pond, or about 185 feet above high-water mark, and which gives it a large tribute of water, and these are the principal sources of what is locally termed the Main Brook, or east branch of Humber River.* The valley of the Birchy Ponds (of which there are three) and of the main river then points downwards south-westerly, maintaining a very straight course for from 12 to 13 miles, where the waters again expand into Sandy Pond, a large and shallow lake, with an area of between 20 and 30 square miles, estimated to lie at the level of 45 feet above high-water mark. The main river then flows out of Sandy Pond, at its south-west angle, and although making a considerable northerly detour in the upper part of its course, bears generally south-westerly, taken from point to point at the head and foot about 9 miles, where it falls into the Grand Pond in lat. 49° 11′ 9″. Within the first few miles after leaving Sandy Pond there is a succession of rapids, which, however, are easily ascended as well as descended under ordinary circumstances; but the lower part of the stream flows broad and deep, with a gentle current to its junction with the Grand Pond. The estimate of the fall altogether, from Sandy Pond to Grand Pond, was considered to be about 11 feet, which would place the latter at 36 feet above the level of the sea. The continuation of the main river leaves the Grand Pond at its north-western angle about 3 miles from the inlet, and flowing very rapidly in a north-westerly direction for a few miles, is joined by the main river Humber flowing from the north, after which the course is south-westerly to Deer Pond. From Deer Pond the river again flows south-westerly, and finally falls into the sea at the head of the southern arm of the Bay

* The original estimates made of the differences of level on the waters of the Indian Brook and Humber River were considerably under the reality. Those given on the new map are the result of subsequent observations made in 1879 (see Report for 1879).

of Islands. A portage from the Grand Pond cuts off the great bend, and striking the main river a little above its junction with Deer Pond, also avoids the rapids in which the greater part of the fall is made. Boats and canoes have run these rapids, although they are said to be both difficult and dangerous; but below the termination of the portage the river is easily navigated to the sea.

I have entered thus particularly into the above details, to show the wonderful facilities that exist for the establishment of water communication by canal from shore to shore; the importance of which can scarcely be overestimated, should the time arrive when mining is being actively pursued on either coast, and workable seams of coal be discovered in the interior.

The valleys in which the rivers flow, between Hall's Bay and Sandy Pond, run, as may be seen by the map, in a remarkably straight line about north-east and south-west, bounded on either side by ranges of hills rising from about 800 feet to 1300 feet. At Birchy Ponds two conspicuous mountains, called Steepmore on the one side and Andrew Cole on the other, are scarcely 2 miles apart, their sides rising boldly from the water's edge; but the valley gradually expands towards the north-east, and on the Indian Brook, particularly near and below the Indian Pond, there are intervals of very good land. From Steepmore the southern range bears away in a south-westerly direction, running for the Lobster-House and Hind's Mountains (see map); while the northern range bears off to the north-westward from Andrew Cole, and afterwards bending to the northward points towards the head of White Bay. Spots of good land were observed on Birchy Ponds and the river lower down, especially near the junction of the larger tributaries; and at Freemason's Point, at the foot of the middle pond, there are white birch, pine, and other trees of large size.

Sandy Pond is surrounded by a great extent of marshes or low, flat, sandy plains, which on the east side are bounded by the mountains already alluded to as bearing towards White Bay, and on the west by a low and rounded ridge, showing no bold and prominent peaks like the hills opposite, but covered thickly with trees, among which there are many white birch, to the extreme summit. The valley of the river below Sandy Pond stretches out in the direction of the Grand Pond into a vast plain, dotted in all

directions with innumerable small sheets of water, and isolated woods, surrounded by marsh or mossy barrens.

The Grand Pond is a long narrow sheet of water, stretching from north-east to south-west about 48 miles, and then turning off to the westward for a few miles more towards its extreme head, terminating with an entire length of nearly 56 miles in lat. 48° 40′ 25″. The north-eastern end of the lake is about 5 miles wide, but it contracts gradually towards the south-west, and at Whetstone Point (see map) is not over 2 miles across, varying from that width to about 3 miles, until reaching Great Pond Point, to the south-west of which it expands from 4 to 5 miles, maintaining that width up to the westerly turn at Sandy Point, and enclosing in its middle a great island, which of itself has a length of about 21 and an average breadth of 2 miles.

The country to the north of the Grand Pond, over a great extent, is low, and much of it is marshy, with numerous small ponds; but there are also considerable tracts of light sandy soil, giving a very fair quality of land, and frequently producing large hard-wood trees, as well as pine, balsam, fir, spruce, and tamarack or juniper. The shores of the lake, except at the northern end, may be termed mountainous; the mountains on the south-east rising boldly in some cases to the height (as at Old Harry) of nearly 1600 feet, bare and barren at the summits, while those in the north-west, although attaining a considerable elevation, are softly rounded in their outline, and are covered with dense woods to the highest parts. The greater part of the western shore, opposite the Great Island, and the shore of the island itself, consists of nearly mural cliffs, which attain an elevation of from 400 to 600 feet.

Away to the eastward of the east-shore range, of which the mountain called Old Harry, in lat. 49° 1′ 49″, forms about the most conspicuous summit, there lies an extensive plateau, at an average elevation of about 1670 feet above the sea, bounded on the east by the range of Lobster-House and Hind's Hill (see map). Viewed from the tops of the mountains, this plateau resembles a rich agricultural plain, browned with the stubbles of autumn, prettily interspersed with isolated woods, and dotted over by lakes and ponds; but the delusion is readily dispelled on reaching the ground, which consists of an almost unbroken tract of marshes and barrens. Running nearly due north and south, this tract

extends between the mountain ranges to Sandy Pond on the north, and to within a short distance of the great Red Indian Pond on the south, containing in its course a series of large lakes, of which Hind's Lake is the largest. Hind's Lake is drained into the Grand Pond at Hind's Point, the stream cutting a deep gorge through the hills; while the ponds immediately north from it drain into Sandy Pond at its outlet. The mountain range on the east side of the plain maintains great regularity of height and uniformity of appearance, except where broken through by Lobster-House and Hind's Hill, which rise precipitously on nearly all sides of it, forming landmarks to the trapper or traveller that cannot be mistaken. From the summit of these hills the country, viewed to the north-east and eastward generally, is one continuous barren, sprinkled over with groves of stunted tamarack, and interspersed with ponds and marshes as far as the eye can reach. During the seasons of migration this region abounds with reindeer; while otter and beaver are plentiful on the lower waters. There are also numerous indications of the presence of the bear, the wolf, the fox, and the marten. Of the feathered tribe, wild geese and black ducks apparently breed here in vast quantities, while the ptarmigan or native grouse are met at every turn.

The hills, constituting what is called the Long Range, interrupt the straight continuity of the great valley, which (as may be observed by reference to the map) extends from Hall's Bay nearly to the head of the Grand Pond; the rest of the direct route to St. George's Bay being performed by a portage of about 15 miles in a south-westerly direction, crossing the mountains near Hare Head, one of the loftiest in the immediate region around. On the south-west flank of the mountains the country becomes marshy, and that character obtains more or less to the river-head arm of the Bay St. George.

A small rapid tributary, called Spruce Brook, falls into the Grand Pond at its extreme head, the general course of which upwards is nearly west for about 6 miles; and then, bending abruptly to the north-eastward for about as many more, terminates in some small lakes. The country passed through by the lower reaches of the stream is for the greater part low and marshy; but the upper parts flow through a fine undulating calcareous tract, where large yellow birch, pine, balsam fir, and spruce abound;

the surface being richly carpeted by the plant known as ground hemlock, indicating a soil of good description. This calcareous tract probably extends from the valley of the Spruce Brook to the head of the southern arm of the Bay of Islands on the one hand, while on the other it seems to run by the valley of the stream known as St. George's Main Brook, towards Port-a-Port, and probably to Cape St. George. The region generally, although hilly and sometimes abrupt, is not altogether mountainous or precipitous, and the interval lands in the bottoms and valleys, judging from the quality of the soil at the base of the hills on the north side of the Bay St. George, where excellent crops, both grain and green, are grown, are capable of supporting a very considerable population, and would afford grazing ground of admirable description for cattle and sheep.

Proceeding now to the geological division of the subject, my remarks will for the present chiefly apply to the distribution of the Carboniferous formation; the probable position of workable seams of coal; and to the presence of mineral substances of various kinds suited for economic application. At a future time, when the materials for a report have been fairly studied out, I shall hope to be able to enter more fully into details.

As the Carboniferous formation of Newfoundland is clearly an extension of the same rocks which constitute the coal-fields of Cape Breton and Nova Scotia, I, on my return from Bay St. George viâ Sydney, C.B., took the opportunity of examining the measures there, in order the more fully to assure myself of the position of the workable seams of coal, as well as the masses of gypsum, occupied in the vertical geological section; and I was further aided by some valuable information given by Mr. Poole, the superintendent of the Glace Bay Mines, and by Mr. Brown, of the Sydney works.

The rocks of the coal formation in Newfoundland, as in Cape Breton, consist of conglomerates, sandstones, red, green, and black shales, with concretionary bands of limestone or dolomite. The base of the formation is usually represented by a coarse conglomerate associated with beds of very micaceous sandstone, and some very red shale. These are succeeded, in the ascending order, by beds of grey, greenish, often drab-weathering sandstone; always

more or less micaceous, sometimes coarse in texture, becoming in some instances a fine conglomerate, and at other times of very fine texture and regular lamination. These beds are usually associated with a very black or bottle-green argillaceous shale, with occasional hard, yellow-weathering, nodular or concretionary bands of impure limestone. Fragments of carbonised plants are abundantly scattered through the sandstones, and small irregular seams and nests of coal occur frequently. With the Lower Carboniferous measures, gypsum occurs sometimes imbedded irregularly with the stratification, but more frequently in masses protruding through it. The upper part of the group, in Cape Breton, consists chiefly of strong beds of sandstone with argillaceous and bituminous shales, amply stored in many parts with fossil remains, chiefly ferns and other plants, characteristic of the coal formation; and it is in this part of the section that the workable seams of coal have hitherto been discovered.

The coal formation is probably the most recent group of rocks exhibited in Newfoundland (excepting always the superficial deposits of very modern date, which are largely made up of its ruins), and there may have been a time in the earth's history when it spread over the greater part of the land which now forms the island; but a vast denudation has swept away much of the original accumulation, and left the remainder in detached patches, filling up the hollows and valleys among the harder and more endurable rocks of older date, on which it was at first unconformably deposited. One of the most important of these detached troughs or basins of coal measures is in the Bay St. George, where the formation occupies nearly all the lower and more level tract of country between the mountains and the shores of the bay; and another lies in a somewhat elongated basin from between the more northern ends of the Grand and Deer Ponds and White Bay; the eastern outcrop running through Sandy Pond, while the western side probably comes out in the valley of the Humber River, near the eastern flank of the Long Range Mountains. There is also reason to suspect the presence of a smaller trough of the same rocks, between Port-a-Port and Bear Head, towards the Bay of Islands, the greater part of which, however, is probably in the sea; and from local information I received from the Indians, as well as some residents at the Bay St. George, I think it not

improbable that another trough of the formation may occur in the region of the Bay of Islands.

Following the outcropping edge of the northern trough, the base of the coal formation is found on the east side of the Grand Pond, opposite the northern end of the Great Island; from whence it skirts that shore of the lake in a narrow belt to the immediate vicinity of the Old Harry mountain, where it runs under the water for a short distance, reappearing on the points between Old Harry Brook and Hind's Point; and again, striking into the interior at a short distance to the northward of the latter point, it bears for the base of the Conical Hill, crossing Coal Brook, and pointing towards the lower end of Sandy Pond. The immediate contact with the underlying rock is usually concealed, but the nearest exposures were invariably a greenstone with epidote, which forms the lower range of hills; the main range immediately in rear being of gneiss. The same measures run across the northern point of the Great Island, and striking the western shore near Bucket Cove, bear away in a northerly course for the northern end of Deer Pond. About 2 miles to the northward of Bucket Cove, beds of coarse conglomerate, interstratified with very red shales, which form a lofty and, from the colour of the shale, very conspicuous cliff, were found resting against a mass of epidotic greenstone; but the rock immediately to the southward and towards Bucket Cove is mica schist, with hard, greenish, very micaceous sandstone or quartzite, the geological age of which I am not yet in a position to state with certainty.

Considerable disturbance is manifested in the cliffs on either side of the greenstone; the strata towards Bucket Cove being tilted in some parts so as to dip in various directions, and at others for a short space to appear nearly horizontal, while the conglomerates and red shales at the point are turned up at an angle of 60°, dipping to the south. The cliffs on the coast northwards display a succession of undulations in the stratification, dipping alternately to the south-eastward and north-westward, by which the same measures are several times repeated; the continuous regularity of the beds being also frequently interrupted by faults or dislocations of greater or less magnitude; but towards Whetstone Point these disturbances are less obvious, and beyond that point, approaching the northern end of the lake, the dip appears to

decrease until reaching the entrance of the main brook, where a low section of brown-coloured, coarse-grained, ferruginous sandstone comes out from below the superficial deposit of sand, in a nearly horizontal attitude.

In the valley of Coal Brook the sandstones are exposed in cliffs from 20 to 60 feet high, where they are in some parts considerably tilted, more particularly near their junction with the greenstone of the Conical Hill, which probably is intrusive. To the northward of the Conical Hill the rock is mostly concealed, but the level character of the country seems to indicate the probability of there being little disturbance. Fossil plants, the bark of the stems of which were always converted into coal, abound in some of these sandstone beds on both sides of the lake, and at Coal Brook; and thin irregular seams and nests of coal were observed in several places. Mr. Jukes, in his work on the Geology of Newfoundland, mentions the occurrence of a seam of coal 6 inches thick on the Coal Brook; but this seam I did not see, its outcrop, probably, in the interval since his visit, having been covered over by débris from above, which it is evident is constantly falling; sometimes even in heavy landslips bearing the trees and bushes in inextricable confusion along with them. Small fragments of coal occur on the bed of the brook, however, and are sparsely scattered among the gravel along the shores of the Grand Pond, near its mouth. There is clearly a seam of coal near the outlet of the main brook, part of the outcrop of which appears to lie between the mainland and the small island I have called Seal Island, from the number of seals that frequent its shores; as, on every occasion when the lake has been agitated by strong westerly winds, quantities of small angular fragments of coal are washed upon the beach; but the great accumulation of sand and boulders, both on the main shore and on the island, together with the vegetation which surmounts it, effectually conceals the strata from view, where the outcropping edge might reasonably be expected. Judging from the fragments found, however, which in some cases appeared to produce the whole thickness of the seam, it is probably of but little importance; although by the process of boring through it the facts might easily be ascertained. Similar small seams and nests of coal occur in the lower part of the formation in Cape Breton, but there is, so far as yet known, a vertical thickness of

several hundreds of feet between the position of those and the lowest workable beds; so that reasoning on the analogy that exists between the circumstances in the one case and those in the other, and supposing the sandstones of Grand Pond to be the equivalents of those holding the same general characteristics in Cape Breton, the inference will be that the workable measures will most probably occur at a higher geological horizon. From what I have been able to observe, if the workable beds of Cape Breton exist at all in the central trough of Newfoundland, the country where they may be expected to be found will be in the region between the Humber River and Sandy Pond, where there is ample room to bring in a sufficient accumulation of thickness; although the character of the country in that part is sorely against surface examination, it being in a great measure covered over by dense vegetation or marsh.

On the north side of St. George's Bay, between the narrow isthmus of Port-a-Port and Romain's Brook, thin flaggy beds of sandstone, some of a red and others of a greenish colour, come against a mass of limestone strata by a fault. Between the exposure of these rocks and Romain's Brook a great accumulation of drift material, consisting of clay, gravel, and sand, rises in high bold banks over the shore, concealing the older rocks; but the sandstones again appear inside of Romain's Brook, associated with a great mass of gypsum. In this case the gypsum apparently protrudes through the sandstone beds, which are brushed up against its sides, and it forms a cliff of itself for some 8 or 9 chains, with a height in some parts of about 60 feet on the left bank of the stream. To the eastward the gypseous mass is indicated by the occurrence of several deep symmetrical depressions or hollows on the land—a phenomenon well known to accompany the presence of the same mineral in other parts of the world. Beds of a soft, greenish, micaceous sandstone, with some red bands, rest against the southern flank of this gypsum, dipping in a southerly direction away from it about 20°; the surfaces of many of which are sprinkled over with small fragments of carbonised plants, exactly of the same character as seen on the lower sandstones near Sydney in Cape Breton and on the Grand Pond. A great proportion of this mass of gypsum is pure white, and admirably suited for cement or stucco; but portions of it are of a

pinkish colour, and other parts are deeply stained with brown, probably the effect of decomposing iron pyrites. Large dark-green crystals of selenite abound in some parts of the gypsum. The coarser gypsum is largely used in Canada and the United States for agricultural purposes; there being raised chiefly for that purpose in the valley of the Grand River, Canada West alone, nearly 14,000 tons annually.* Although the dip of the sandstone at its junction with the gypsum is moderately high, it seems probable, from the character of the country to the eastward, that it slopes gently with waving undulations away from the mountains towards the sea, interrupted only by a set of crystalline rocks supposed to be of Lower Silurian age, which rise at Indian Head, and compose the hills which look over the north-east angle of the bay. In this case, supposing the dip to be regular at a rate of 7° to the horizon, a distance of 7 miles across the strike would bring in a thickness of strata amounting to about 4300 feet, and consequently, in all probability, that part of the formation in which the workable seams of coal may be expected; and in like manner a regular dip of 20° would accumulate the same amount of measures in less than 2 miles; but, on the other hand, if the rocks are affected by undulations repeating the same strata once or more, the thickness will obviously be proportionally so much less according to the circumstances. About 7 miles distant from the gypsum on Romain's Brook, a seam of coal occurs on the bank of the Indian Brook, which, however, does not appear to be of any great thickness. It rests on a dark-coloured argillaceous shale, which contains a fossil very much resembling *Stigmaria ficoides*; which fossil invariably underlies every true seam of coal known, either on this or the other side of the Atlantic; being, in fact, the roots and rootlets of the trees which grew on the spot and produced the accumulation of vegetation which time and circumstances have converted into coal.

The south side of the Bay St. George I had no time nor opportunity of examining personally, but, according to Mr. Jukes, the coal measures on that side are to some extent affected by such undulations as I have attempted to describe, which keep the lower measures near the surface for several miles from the coast;

* See 'Geology of Canada,' p. 763, in which also the prices of the article in various conditions will be found.

nevertheless, there is still ample room for a greater accumulation, and the higher parts of the formation may reasonably be looked for before reaching the mountains. Mr. Jukes, indeed, saw a bed of coal 3 feet thick on the Second Brook,* and I was informed by several residents that a similar seam had been observed about 3 miles to the southward of Flat Bay. Masses of gypsum also occur with the lower measures on the south side, and the sandstones associated with them are characterised by the same obscure fossil remains as they are elsewhere.

A small patch of the coal formation was observed on the high plateau below the Lobster-House range, consisting of a few beds of coarse brown sandstone, cropping out in perfectly horizontal strata, at intervals on the banks of the small lakes; but, further than the fact of its existence, it is of insignificant importance, and is probably not over a few feet in thickness altogether. The conglomerates and sandstones also, which form a trough between the falls of the Indian Brook and Hall's Bay, as well as those in the valley of the Indian Ponds, *may* be Carboniferous; but the entire absence of fossils of any kind in those quarters occasions much uncertainty; and at all events there does not appear to be sufficient room, in either case, between the older rocks which support those beds, to bring in the higher measures. The same remarks apply to the conglomerates and sandstones at the head of White Bay, which, in my communication to the Hon. the Attorney-General Hoyles last year, I classed under the Devonian series.

From the experience gained by the investigations of this year, I think it not improbable that I may further have to modify my views of the last in some degree, as regards the rocks of the two peninsulas on the north-east coast, Cape Rouge and Fox Cape. The fossils I obtained from the formation there were referred to Dr. Dawson, of McGill College, Montreal, for examination, who gave it as his opinion that they belonged either to the upper part of the Devonian system or the base of the coal formation; and I was induced to take the former view from the similarity, in other respects, the rocks bore to those of Gaspé, of admitted Devonian age. Now, however, having seen fossils apparently identical with those of the Cape Rouge section, at the base of the coal measures at Sydney, I cannot help suspecting that the section of those

* Since called Middle Barachois—Report for 1873.

peninsulas, or a part of it, is coal measures also; and if such is the case, as there is a considerable accumulation of strata there, it is quite possible that the part containing seams of coal may be brought in.

I have been induced to enter thus particularly into the circumstances connected with the coal formation, in the hope that in some degree my remarks may act as a guide to future explorers, as well as to prevent, as far as possible, a useless outlay of labour and money in the vain attempt of searching for coal in rocks of an earlier period than the Carboniferous, where there is scarcely the remotest probability of its existence. In former times, thousands if not millions of money have been uselessly expended in Great Britain, in the United States, and to some extent in Canada, in exploring, boring, and sinking for coal in older rocks than the true coal formation, which a little knowledge of geological structure might have saved for more substantial purposes—a circumstance which ought, of itself, to prove that proper geological information has its *negative* as well as *positive* advantages.

The Carboniferous system, as a general rule, may be expected to supply economics of no inconsiderable importance, in addition to the coal itself and the gypsum at its base; such, for example, as iron ore, usually in bands of kidney ironstone, building stone, grindstones, and whetstones; all the three latter of which are well represented in the rocks of the formation on the Grand Pond.

It has already been stated that the lower sandstones of the coal formation come against a limestone at a point between Romain's Brook and the isthmus of Port-a-Port, in the Bay St. George. This limestone strikes along the shore in the direction of Cape St. George, and may probably reach that point, although, being unable to follow the coast, I cannot state that it does so with certainty. Inside of the Bay of Port-a-Port beds of limestone run along the shore, dipping at a moderate angle to the north; but at the head of the coves, or identations of the coast, these rocks are brought abruptly against another set of calcareous strata by a fault, the fossils of the latter of which appear to me to indicate a much more recent formation than those of the former.*

* Since this was written, I have received a communication from Mr. Billings, through Sir W. E. Logan, whose opinion with regard to these fossils quite confirms the views expressed in the above. Mr. Billings' words are: "This limestone is certainly of Lower Carboniferous age, for although the three latter of the fossils are

The calcareous rocks on the southern side of the fault are very much crushed and broken, but are crowded with beautiful fossil remains; while the limestones on the northern side, which are also fossiliferous, are of totally different mineral quality, and the fossils of entirely a different type. Running in the line of the dislocation, which at one part bears N. 65° E., S. 65° W., but which generally perhaps has a more nearly east and west course, galena, or the sulphurate of lead, is scattered in cubes, or reticulates in strings through an aggregate of large rhomboidal crystals of calc-spar. The fault shows itself at intervals, with these minerals, at the heads of several of the deeper coves on this part of the coast, and, as I was informed by a very intelligent resident, is again to be recognised in the country to the westward, in a valley or gorge locally called Piccadilly. The condition in which this galena occurs is such as to warrant diligent investigation and trial on the part of mineral explorers, as there is great probability that in some parts of its course the lode may be found to produce a remunerative supply of the ore.

The fossils of the limestones which skirt the shores of Port-a-Port Bay, immediately to the north of the fault and lead vein, appeared to me to be of Lower Silurian age.* They are very bituminous, emitting a strong fetid odour by a blow of the hammer. Following the strike of this formation to the eastward, it forms the Table Mountains, and farther still into the interior, the hills on the north-west side of the St. George's Main (since called Harry's, 1874) Brook, and the upper valley of Spruce Brook, apparently making for the head of the southern arm of the Bay of Islands where Mr. Jukes reports the presence of limestone with beds of white marble.

There are rumours of coal having been seen by the Indians, many years ago, in the valley of the Spruce Brook, which however I found, on making particular inquiry, *did not occur in solid rock, but in broken fragments*; and this may possibly be the case,

not determined specifically, there is no mistaking the types to which they belong. The *Terebratula sacculus* (this refers to the list of fossils named) is, on comparing specimens, undoubtedly identical with the species from Nova Scotia that Davidson has examined and figured under that name."

* Of these limestones, Mr. Billings says: "This rock is the upper part of the *true Calciferous* (i. e. Lower Silurian), and lies next below the Levis formation. They belong to the divisions H, I, K, L, M, 'Geology of Canada,' p. 879."

but if so, was most likely a portion of the many erratic boulders conveyed by ice or other agency, at a remote period, from a distance.

Whilst in the neighbourhood of Port-a-Port, I was informed that a bituminous substance, resembling petroleum, had been observed on the middle long point on the west side of the bay, and also that native copper occurred on some part of the main coast farther north; but I was effectually prevented from visiting those localities, notwithstanding my great anxiety to do so, by a succession of furious storms, which rendered all travelling, either by land or water, utterly impossible.

In conclusion, I have only further to remark that the difficulties to be encountered in attempting to work out the geology of this Island are of no ordinary kind, and will require time and much hard labour to do so even in the most superficial manner. What with the too general inaccessibility of the seaboard, where the best sections of the rocks are to be found; the difficulty of travelling in the interior; the absence of topographical maps or surveys of any kind, except of the coast, on which to place the smallest reliance; and in addition to all, the highly disturbed and altered state of the older formations, together with a very general absence of organic remains to act as guides,—the explorer, it may be admitted, has a sufficiently arduous undertaking before him. In Great Britain, where every part of the nation is so easily accessible, with maps so accurate as to be almost absolutely perfect, with an able and ample staff directed by Sir Henry de la Beche or Sir Roderick Murchison, years have sometimes elapsed in the examination of a single county; while in Canada a well-organised staff, under the direction of Sir W. E. Logan, were incessantly occupied, for upwards of twenty years, before the structure of the country was properly understood.

I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

To His Excellency
The Governor of Newfoundland.

CHAPTER IV.

LETTER ADDRESSED TO HIS EXCELLENCY ANTHONY MUSGRAVE, DATED JANUARY 28TH, 1867—ACCOUNT OF AN ACCIDENT.

St. John's, Newfoundland,
January 28th, 1867.

May it please your Excellency,—

In consequence of a serious injury I had the misfortune to meet with while prosecuting my labours on the west coast of this Island last summer, I have been incapable since my return here of completing the material requisite to illustrate the results of my recent investigations, upon which to frame a preliminary report to be laid before the Legislature. The work, however, is now in progress, and with the assistance of Mr. J. T. Neville, who is working up the plans from my field drawings, I hope to be prepared to furnish you with the required documents in the course of next month.

In the early part of the season I took the opportunity, while detained at St. John's, to measure a section of the rocks near Topsail and on Kelly's Island in Conception Bay, which section, together with certain facts since ascertained, is likely to reveal some very important information as to the geological structure of the country. I was afterwards chiefly occupied in continuing the examination of the Carboniferous formation on the western side of the Island, commenced last year; and in connection with the examination I found it necessary to make topographical survey of the rivers Great Codroy and Humber, as well as a portion of the country between Flat Bay, in the Bay St. George, and the mountains to the southward; and a good section of the Carboniferous measures was obtained along the coast between Cape Anguille and Cape Ray.

A partial examination was also made of the coast between Cape St. George and the Humber River, and various parts were visited on the southern coast of the Island, during the latter part

of the season, for the purpose of acquiring as much information as possible on the subject of the general distribution of the geological formations, together with the mode of occurrence of certain metalliferous ores.

Plans of the country surveyed will be submitted to your Excellency on a scale of one statute mile to one inch, together with a general plan on a scale of four miles to one inch, brought to connect with my survey of 1865, which will serve to explain the text of the narrative intended to accompany them.

I trust it will be admitted, when the documents alluded to are laid before your Excellency and Council, that the work done, so far as it goes, gives considerable useful information, which in course of time may turn to the advantage of the colony, although I am too well aware that it might have been much more perfect had it not been for the untoward accident that has rendered me a cripple to the present day.

I endeavoured, whilst prosecuting my explorations, to collect some specimens of the rocks and minerals of the country in aid of the local commissioners for the great Exhibition, shortly to be held in Paris; but this collection is also quite unequal to what it might have been had my physical condition permitted more active exertion; yet it is still my ambition, should I receive permission from the Government to visit Europe for a part of the coming summer, to do my best to draw public attention to the mineral and agricultural resources of this country, which I have little hesitation in saying are in the meantime only very imperfectly understood.

I have, &c.,

(Signed) ALEXANDER MURRAY.

His Excellency the Governor,
&c. &c. &c., of Newfoundland.

CHAPTER V.

REPORT FOR 1866.—SURVEYS OF THE CODROY AND HUMBER RIVERS—NOTES ON THE CARBONIFEROUS ROCKS OF ST. GEORGE'S BAY, AND CENTRAL COUNTRY.

St. John's, Newfoundland,
1st *March*, 1867.

May it please your Excellency,—

I have the honour to furnish you with the following narrative of my proceedings in the prosecution of the geological survey of the Island during the past season, preliminary to a more detailed report which, in due course, I shall be prepared to present through Sir W. E. Logan.

As in the course of my investigations it was necessary to visit places on the coast remotely distant from each other, with which there was no direct communication, it was deemed expedient that I should be supplied with a small vessel for that purpose, and accordingly the schooner *A. M. W.*, of Harbour Grace, with a crew of four men, was placed at my disposal.

After some little unavoidable detention in fitting out the vessel, I sailed from St. John's on the 4th July, and returned thither on the 21st November, 1866.

The plan of the expedition was (as already intimated by Sir W. E. Logan, in his letter to the Hon. F. Carter, accompanying my report to him for the year 1864) to follow out the limits and distribution of the coal formation, which had been partially examined last year, and to trace out any workable seams that might be met with; at the same time to take particular note of the older formations at the various parts that might be visited, in order to be the better prepared to follow out their distribution at a future time.

In connection with the examination a considerable amount of topographical surveying was required, there being no recently published charts of those parts of the western coast which were

likely to be convenient as starting-points; I therefore deemed it necessary to supply myself with a good chronometer for the purpose of ascertaining longitude from time to time, by means of which, with latitude found by observations of the sun or a star, the position of such places might be laid down with some degree of accuracy.

The earlier part of the season was devoted to an examination of the coast between Cape Ray and Cape Anguille, where a good section of the coal formation was obtained, and a survey was made of the Great Codroy River and Valley. I then proceeded to the Bay of Islands, examined the coast between Cape St. George and Round Head on the way, and commencing in Humber Arm, surveyed the main river and valley for about 50 miles up its course, by which I was enabled to connect the work of the present with that of last year. Lastly, I repaired to the Bay of St. George with the intention of extending my survey from the south coast of the bay by the valleys of the various brooks, so as to connect that part with the survey of the Great Codroy; thereby also obtaining a transverse section of the coal measures of that region. This part of my plan was but partially accomplished, as I only succeeded in surveying the Flat Bay; at the same time fixing the position of the most conspicuous mountains to the southward by triangulation, and scaling two of the streams, viz. the Barachois and Flat Bay Brooks.

My operations during a considerable part of the season, and particularly while in St. George's Bay, were materially retarded in consequence of a very serious accident which I had the misfortune to meet with while examining the cliffs near Cape St. George, by which I was rendered incapable of walking without assistance, and had to limit my investigation to such places as were more or less accessible by a boat or canoe. Under these circumstances I was, with the greatest reluctance, compelled to abandon my intended visit to the spot where a 3-feet seam of coal is represented to exist by Mr. Jukes, in his work on the Geology of Newfoundland, and which I had resolved to examine and trace to its furthest limits, in order to ascertain whether or not it was likely to prove of commercial importance.

Previously to sailing from St. John's, I visited Topsail and Kelly's Island in Conception Bay, for the purpose of ascertaining

the relation between the rocks which form the lofty cliffs of the mainland there, and those of the sea-coast and the group of islands—a subject which may probably turn out to be one of paramount importance, when further investigated, in revealing the geological structure of the Island.

A very good section of the more recent formation was obtained on Manuel's Brook, at Topsail Head, and at Kelly's Island; but the obscurity or absence of organic remains renders it still unadvisable to express too decided an opinion as to the horizon to which they belong, or the age of the series upon which they repose unconformably.*

Returning from the westward, several parts of the southern shore were visited, and every possible opportunity taken to obtain information respecting mineral indications and the character of the rocks with which they were associated. Thus some considerable time was occupied in Hermitage Bay and Bay D'Espoir, where I was much indebted to Mr. Bradshaw, Collector of Customs at Gaultois, for assistance; and finally the season was concluded by visiting the La Manche Lead Mine, near the head of Placentia Bay, touching at Burin, Isle Valen, and other parts on the western side of the bay, on the way thither.

Geographical Description of the Great Codroy River.†

The Great Codroy River runs into the sea, in lat. 47° 50′ 14″, long. 59° 19′ 55″, between 15 and 16 miles north from Cape Ray, and about 6 miles south-easterly from Cape Anguille. The entrance from the sea is very narrow, passing between banks of sand and gravel, and several bars and reefs of the same material stretch outwards to a considerable distance, which moreover are frequently shifted in position by the violence of the storms from without by which they are assailed, rendering the approach even for small craft very difficult and dangerous; although when once

* Since the above was written a fossil has been placed in my hands by C. F. Bennett, Esq., which is said to have been found by Mr. A. Harvey, of this place, on the larger Belle Isle in Conception Bay. A photograph of this fossil was forwarded to E. Billings, Esq., palæontologist of the Geological Survey of Canada, who at once recognised it to be *Cruziana semiplicata* (Salter), a form characteristic of the *Lingula* flags near the extreme base of the Silurian system.

† All the bearings are from the true meridian.

inside there is an excellent harbour, sheltered thoroughly from all weather.

Measuring from the lower part of the estuary, a little way north from the point where the latitude and longitude were ascertained (see plan), the general courses ascending the river are as follows:—

	Miles.	Chains.		Rise.
1st reach, N. 81° E.	6	0	to head of estuary or lagoon ..	Tide-water
2nd reach, N. 55° E.	8	60	to the lower main fork, say ..	18 feet
3rd reach, N. 53° E.	4	60	to second main fork	15 „
4th reach, N. 86° E.	3	25	to the end of survey	12 „

The lower part of the first reach is wide and open, but flat and shallow over the whole area, except where the main channel cuts through, where there is sufficient water to float vessels of considerable size for upwards of 3 miles, when high tide. The upper part of the same reach also spreads over a large space, but it includes some low islands which extend nearly to the point where the current of the river becomes perceptible.

The second reach is more or less rapid, and at a little over 4 miles up it, or about half-way to the lower main fork, there is a little fall of about 2 feet; the total rise on the whole reach being estimated to be about 18 feet. At the head of this reach the river is split into two streams, of about equal size, the one turning a little north towards the Anguille range of hills for about 3 miles, after which it bends again to the eastward at the southern base of these hills, and runs parallel to them; while the other bears upwards on the third reach in nearly the same course as before, gradually approaching the Cape Ray or Long Range Mountains, which it enters on the fourth reach above the second large fork. The second fork joins the main river on the south side, proceeding from a gorge of the Cape Ray mountains, at about 1 mile distant from it. Between the first and second forks the main river was estimated to fall at the rate of about 3 feet in a mile, making a total of about 15 feet, and the upper reach, where it becomes a mountain torrent, at the rate of about 4 feet, giving about 12 feet more to the end of the survey; thus giving a rise in the measured length of the stream of about 45 feet.

Besides the forks already mentioned, there are numerous tributaries to this river falling in on either side, among the most

important of which there are two in the lower reach on the north side, flowing from the Anguille range; one opposite the first fork, at the head of the second reach falling from the Cape Ray mountains, and one coming in opposite the second fork at the head of the third reach, which proceeds from north-eastward. The stream at the time of my visit was low, and the measurements had to be made on foot all the way, but when well supplied with water it is easily navigable for canoes up to the second fork.

On the coast, 4 miles south from the outlet of the Great Codroy River, is Larkin Point, immediately south of which the waters of the Little Codroy River are poured into the sea.

This stream runs parallel to and not far from the north-western base of the Cape Ray range for the whole or greater part of its course, receiving many tributary streams from the mountains on its way. Above the estuary, at its mouth, it is very shallow and rapid, and inaccessible for canoe navigation.

The Cape Ray mountains, which bound the fine valley drained by these two streams on the south-east side, are bold, bare, barren, and picturesque, but they nowhere attain an elevation much above 2000 feet, and are for the most part, according to measurements made both by triangulation and barometrical observations, considerably below that altitude. On the other hand, the Cape Anguille range, which bounds the valley on the northern side, presents a soft and gentle outline, where the higher elevations attain an altitude of from 1000 to 1300 feet, richly covered by forest trees nearly to the summits.

The flat or low land, forming the lower part of the valley between the two ranges of hills, extends on the sea-coast from the neighbourhood of Trainvain Brook, 3 miles south from the mouth of Little Codroy River, to within a short distance of Cape Anguille, giving a breadth of 12 statute miles; but the hill ranges converging slightly towards each other in their north-eastern course into the interior, the valley gradually becomes more and more contracted in width until shut in nearly altogether, where the main stream at the end of the survey becomes split up among the mountains of the Long Range into a succession of small turbulent mountain brooks.

The area occupied by level or gently undulating land in the valley amounts by rough measurement on the plan to about

75 square miles, or 48,000 square acres, a very large proportion of which is available for settlement. For the most part, the country is well wooded with stout mixed timber, consisting chiefly of spruce, balsam-firs, yellow birch frequently of large size, white birch, and tamarack; but there are also frequent spots of barren or spongy marsh entirely void of timber or only maintaining a very stunted growth of evergreens or small tamarack bushes. The islands and flats of the lower part of the Great Codroy River yield a luxuriant growth of wild grass, affording an ample supply of admirable fodder for cattle. Along the sea-coast, between Trainvain Brook and the little village of Codroy, the country is partially settled all the way, the attention of the settlers being about equally divided between the cultivation of the land and fishing operations; but up the Great Codroy River, which is more or less occupied on either side of the estuary, the calling of the inhabitants appears to be more nearly purely agricultural, and it may be fairly stated that, notwithstanding the very rude process by which the land is cultivated, the crops produced of grass, grain, and roots, highly testify to the excellence of the soil in which they are grown. Cattle and sheep are raised upon most of these small farms, producing most excellent beef and mutton, besides dairy produce of the very best description.

The greater portion of the Anguille, and some portions of the lower slopes of the Cape Ray range also, are quite capable of improvement, and if cleared of timber and sown in grass, would afford grazing land not easily surpassed in any country.

St. George's Bay and Coast to Humber Arm, Bay of Islands.

While examining this part of the western shores, I took every available opportunity of getting astronomical observations, in order to correct as far as possible certain discrepancies suspected to exist in the published charts. The result has proved of importance, as a very considerable error in both latitude and longitude was found to exist in the representation of a great part of St. George's Bay and the Bay of Islands.

These corrections must be taken only as approximative; but as the geographical position, found by the observations taken at

one or two well-marked places, very nearly coincided with those determined by Captain S. Cloue, of the French Imperial Navy (whose admirable and well-known accuracy requires no comment), they may be taken as moderately trustworthy. St. George's Harbour, the only harbour in the bay, was one of the parts found to be very inaccurately represented, not only as regards geographical position, but in the contour of the coast, so that it was deemed necessary to triangulate the whole of Flat Bay in order to get sufficiently accurate data to start with before fixing the position of the mountains and rivers of the interior. Harbour or Sandy Point, at the entrance to Flat Bay, is in latitude 48° 27′ 27″ N., and longitude 58° 30′ 30″ W. It is the termination of a long low spit of gravel and sand, projecting from the mainland for nearly 6 miles, and enclosing Flat Bay and St. George's Harbour. There is an excellent and secure anchorage for vessels of nearly all sizes immediately under this point, and a moderately deep although somewhat tortuous and narrow channel runs up nearly the whole length of Flat Bay, but all the rest of its area is exceedingly shallow, much of it being entirely dry at low ebb tides.

A stream known as the Barachois Brook falls into the sea a little way outside of Flat Bay, the entrance being about south-east of Harbour Point, and another of about equal size, called the Flat Bay Brook, falls in near the head of Flat Bay. Both these streams were found to be navigable for canoes for a considerable distance.

The course of the Barachois in a general bearing is N. 65° E. for 8¼ miles, at which distance it opens out into a suite of small lakes at the base of the Long Range Mountains, bearing upwards on the same course for about 2½ miles more, then turning sharply to the southward, the upper lake lies for nearly 2 miles transversely across the hill range, and contracts again at the end of that distance in a narrow and rapid mountain brook. The Flat Bay Brook bears upwards on its general course S. 76° E., 7 miles 60 chains, through an undulating country to the mountain range, which it intersects through a narrow gorge at that distance, still maintaining the same upward bearing for some 4 or 5 miles more in a narrow mountain valley, receiving numerous tributary streams on either side.

The stream is very rapid from the outlet to the mountains, but after entering the gorge the current becomes moderate, as far as it was ascended. At the point where the main stream enters the mountain gorge it is joined by a tributary on the right side flowing from the south-eastward, in the forks of which stands a remarkable and prominently conspicuous hill, which was termed the Cairn Mountain, from the circumstance of a monument having been erected on it, and which afforded an excellent object for triangulation. The summit of this mountain, where the monument stands, was found to be 1012 feet above the level of the sea. The north-western flank of the Long Range Mountains will thus be seen to run in a nearly straight direction, about N. 36° E., from the upper forks of the Codroy towards the Cairn Mountain on Flat Bay Brook, crossing the Barachois at the lakes, and striking for Hare Head at the head of the Grand Pond. Between the hills and the southern coast of St. George's Bay the land is level or undulating, for the most part, thickly grown over by a fine growth of mixed forest timber, and drained by numerous streams, several of which, besides the two already described, are navigable for small boats or canoes for several miles inland. This tract is bounded on the south-west by the high land of Cape Anguille, which rises into a wooded mountainous country about half-way between the Cape and the head of Flat Bay, extending across to the southward to the northern main fork of the Great Codroy River. The maximum width of the level region between the sea and the Long Range is from 10 to 12 miles, but this width decreases advancing to the north-eastward, and is reduced to about 5 miles opposite the Cairn Mountain, while it becomes narrower still at the Barachois Brook.

By a rough measurement made upon the plan the area of the region lying between the mountains and the sea is about 192 square miles, or 122,880 square acres, a very large proportion of which is available for settlement. On the north side of the Bay St. George, also, there is a considerable area of fine agricultural country, extending from the coast between Indian Head and the isthmus of Port-a-Port to the range of the Table Mountains, roughly estimated at about 10 miles in length by an average of 3 in breadth, or about 30 square miles, equal to 19,200 square acres. The present settlement of this fine region

is limited to some straggling farms along the coast on either side of the bay, on which, however, excellent crops of grain, grass, potatoes, and turnips are raised; winter wheat has been grown successfully on Mr. Romain's farm on the north side of the bay, and the hardier varieties of that grain might no doubt be cultivated to a large extent were there a mill in the country to make it into flour; and as there is ample water power upon every brook, mills would readily be constructed if an impetus were once given to purely agricultural pursuits. Many of these small farms even now maintain a good stock of cattle, sheep, horses, pigs, &c., &c., the condition of all of which gives ample testimony to the capabilities of the soil on which they have been raised.

The Humber Arm and River.

Considerable discrepancies were found to exist in the position of this coast as represented in the published charts, especially towards the mouth of the Humber River, where there was found to be an error of upwards of two minutes of latitude; and as one prominent position where observations were taken, namely, the gravel point in Lark Harbour, agrees with the result obtained by M. Cloue at the same place within a few seconds, the outline given upon the accompanying plan may be relied on as tolerably near the truth.

Brake's Landing, at the entrance to the Humber River, was found to be in latitude 48° 57′ 53″ N., and longitude 57° 55′ 32″ W. The following are the bearings and distances on the river, exclusive of minor turns up its course, as far as surveyed.

1st Course.—From Brake's Landing to the head of the lower rapids, at station 9, S. 61° E., distance 3 miles 4 chains.

2nd Course.—From station 9 to entrance into Deer Lake, N. 60° E., distance 8 miles 63 chains.

3rd Course.—Deer Lake from Governor's Point to head of lake, N. 42° E., distance 15 miles 7 chains.

4th Course.—Head of Deer Lake to forks of Grand Pond, N. 44° E., distance 5 miles 14 chains.

5th Course.—From Grand Pond forks to Beaver Pond, N. 38° E., distance 4 miles 12 chains.

6th Course.—From Beaver Pond to Great Bend, N. 56° E., distance 8 miles 46 chains.

The upper part of the arm, towards the entrance to the river, is very shallow over a large area, much of which becomes nearly dry at low water; but there is a deep channel, although somewhat tortuous, by which small vessels can enter the stream; and there is very good anchorage outside the shoals a little way westward of Brake's Landing.

The first or lower course of the river passes through a narrow gorge bounded on either side by lofty calcareous crags, which in some parts rise nearly vertically from the water's edge in cliffs of 1000 feet or more, the whole body of the magnificent river being pent up within sometimes less than a chain in width. The current is tolerably strong and the water deep in this course, and towards the end of it there is a moderately strong rapid. Above this rapid the river opens out wide, flowing through a very picturesque valley, the current being moderate all the way until within about a mile of the lower end of Deer Lake, where another pretty strong rapid occurs. The rise from the sea to the level of Deer Lake was estimated to be only about 10 feet.* Following the course over Deer Lake to the junction with the Grand Pond branch, the current is sluggish, the river wide, sometimes opening to upwards of a quarter of a mile, the water usually deep, and is very easily ascended by boats of any ordinary draught. A little way above the junction of the Grand Pond branch the stream becomes very turbulent, the first rapid making a fall of 11 feet in about a quarter of a mile, and it is more or less rapid and often shallow and difficult of ascent for canoes all the way, except at two parts, where it opens into what are called the Seal Pool and Beaver Pond, where it is still wide and deep. There is also a stretch of some 2 miles, where the current is moderate, below the great bend, above which it turns in a south and south-west course for about a mile, and then, bending round again in the prevailing north-eastern direction for another mile and a half, comes to a vertical fall of about 10 feet, where our ascent terminated. The estimated rise above the sea at the top of the fall was about 90 feet. Above the fall the general course is said to be a little eastward of north for about 8 or 9 miles, where it reaches within less than 10 miles of the head of White Bay, and then, turning westerly for a few miles, runs along the base of the

* Since estimated to be from 15 to 20 feet (Report, 1879).

mountains, and finally turns south-westerly and terminates at Adie's Pond, within about 12 miles distance from the head of Deer Lake, and some 20 miles from the eastern arm of Bonne Bay.

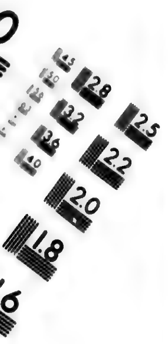
The Grand Pond branch was only ascended for a little over a mile, at the end of which distance the stream becomes violently rapid, and although practicable for canoe navigation all the way to the Grand Pond, it is exceedingly difficult and dangerous.*

The hills at the lower reach of the river, although very precipitous and broken, are nevertheless covered by a dense growth of forest trees, among which are many pines and spruces of large size, well adapted for spars or lumber.

Above, and immediately upon entering the second reach, the valley opens out with a narrow fringe of fine flat land on either side of the river, lying between it and the mountains, which varies in width and extent to Deer Lake, while at Deer Lake it expands gradually more and more, and on the northern side it is in some parts upwards of 3 miles wide. The southern side is more contracted until reaching towards the upper end of the lake, where a great expanse of flat or rolling country spreads away to the eastward and northward, reaching in the former direction to the Grand Pond. Above Deer Lake the flat country is of great breadth, more particularly above the forks; the mountain range which bounds it on the west side pointing in the direction of Adie's Pond at the head of the river on one hand, while on the other it extends to the base of the low wooded range west of Sandy Pond, and this level tract extends upwards on the river's course to the western bend, which is said to be less than 10 miles distant from the head of White Bay. By a rough measurement of this large tract of country made upon the plan there would be an area of about 429 square miles, or 274,560 square acres, at least one-half of which is probably well adapted for raising almost every kind of agricultural produce.

Independently of its agricultural capabilities, this fine tract of country seems to present inducements for other branches of

* Judging from the description given of these rapids, the rise must be at least about 38 feet; therefore, allowing about 2 feet for the fall of the stream from the forks to Deer Lake, and 10 feet as the height of Deer Lake, the Grand Pond will be about 50 feet above the sea, instead of 36 feet, as given last year (since found by level to be 116 feet—1879); and all the other heights on the west side of the watershed will be also proportionally higher than represented.



industry and enterprise in the quality of its timber, much of which is excellent. Tamarack or juniper is not rare; yellow birch of large dimensions is abundant; white pine and spruce grow in the greatest profusion, frequently of a size and quality not greatly inferior if not equal to the best that is now largely brought into market in Gaspé and other parts of the lower province of Canada. The natural facilities this part of the island present for communication also from shore to shore are very great, the valley is easily accessible by water from the Bay of Islands to the Grand Pond forks, while the country farther north is well adapted for laying out roads, and a road of less than 10 miles from the northern bend would open up the whole from the head of White Bay.

Water power to drive machinery is everywhere obtainable, either in the main river on the upper part of the stream, or in the numerous brooks that fall into Deer Lake and the lower reaches.

Thousands of square miles of country have been laid out in townships and already partially settled in Canada, either for purposes of lumbering or farming, on the northern shores of Lake Huron, and many parts of the lower province, far inferior in most respects to this region of Newfoundland, which there can scarcely be a doubt is capable of supporting a very large population.

The mountains of the region, although very rugged and usually barren at the summits, do not reach in any case a very high elevation. The range known as the "Blow-me-downs," which runs to the water's edge, destitute of timber from top to bottom, opposite Harbour Island at the entrance to the arm, appears to be the highest, one summit of which was found by triangulation to be 2086 feet above the sea. Near the river the most conspicuous of the hills, and apparently about the highest, is Mount Musgrave (called so in honour of your Excellency's recent visit to this part of the country), which, towering over the lower ranges towards the mouth, and bearing directly on the line of the lower reach, attains an altitude of 1864 feet. Farther inland, and towards Deer Lake, the general heights are still more moderate, the highest measurement being only 1041 feet over the level of the lake.

In entering on the geological part of the subject, I shall in the meantime confine my remarks to an account of the general distribution of the Carboniferous series, and to the geographical and geological position of the various economic materials which have come under my notice, deferring a more minute detail of the facts and circumstances ascertained until the collection of specimens already forwarded to Montreal have been duly examined and analysed, when I shall be prepared to send in a report to Sir W. E. Logan.

Distribution of the Carboniferous Formation.

The rocks recognised as belonging to the Carboniferous age occupy three distinct areas, being separated from each other by ridges of the older formations upon which they unconformably repose. For convenience they may be classed as the St. George's trough, the Port-a-Port trough, and the inland trough of the Humber River and Grand Pond.

The south-eastern edge of the St. George's trough follows the base of the Cape Ray or Long Range of Laurentian mountains from near the entrance of Trainvain Brook in nearly a straight line towards the upper forks of the Great Codroy River, and then, apparently still keeping towards the base of the mountain range to the Cairn Mountain in Flat Bay Brook, crossing the Barachois Brook, a little below the lakes, and striking for the arm of St. George's River. The northern edge of the same trough appears to be partially divided by a mass of crystalline metamorphic rocks, the age of which has not yet been satisfactorily ascertained, which forms a sharp ridge of hills terminating at Indian Head, on the west side of which the outcrop of the formation sweeps round toward the base of the Table Mountain range of Lower Silurian limestone, and runs out on the shore a mile west of Romain's Brook near the isthmus of Port-a-Port.

The Port-a-Port trough is divided from the St. George's trough by a ridge of Lower Silurian limestone, which extends along the coast across the measures from Cape St. George to a point nearly opposite to Red Island. Red Island is a coarse conglomerate of Carboniferous age, and from it the outcrop was supposed to strike easterly across the peninsula of Port-a-Port into Port-a-Port Bay,

the whole country to the north of which was supposed to belong to the same formation, except the high land called Round Head, which probably protrudes through it. The flat valley of Coal River is also probably spread over by rocks of Carboniferous age, but was not examined.*

The western outcrop of the Humber trough strikes inland from the lower end of Deer Lake, resting against the eastern flank of the long range of gneissoid mountains which run on their northerly course towards Adie's Pond at the head of the river, and then along the left bank of the river towards the western shores of White Bay. The eastern outcrop runs along the edge of the upper end of Deer Lake, making a narrow fringe between the lake and gneissoid mountains until within about a mile of its head, when it sweeps round to the eastward toward the Grand Pond, resting on the flank of the Laurentian hills which constitute the nucleus of the ridge between the two great lakes. The remainder of the outcrop of the inland trough within the Grand Pond country has already been described in a former communication.

The coast between Cape Anguille and Larkin's Point, at the mouth of the Little Codroy River, displays some fine exposures of this formation. Between Cape Anguille and Codroy Island the exposures consist of strong beds of dark grey sandstone, dark blue or blackish limestone, coarse conglomerate, and a mass of black indurated shale, with thin seams of snowy gypsum interstratified with beds of limestone and calcareous sandstone. The western side of Codroy Island exhibits a section of dark grey sandstone, in thick beds, sometimes of conglomerate character, the pebbles arranged parallel to the stratification, with brownish and dark blue, hard, compact, slightly calcareous sandstones, some thin bedded, greenish, coarse-grained micaceous sandstones, with brown arenaceous and micaceous shales; while on the eastern side, at the point of the cove, some beds of hard dark-blue limestone alternate with brown yellow-weathering sandstones in thin beds. In mostly all of the above-mentioned strata comminuted and carbonised plants were observed, in some cases in great profusion, especially among the softer sandstones and shales; and at the northern end of Codroy Island an accumulation of vegetable

* For further particulars, see Reports for 1873-74.

remains of about 2 inches thick may be styled a thin seam of coal.

The coast southerly from Codroy Island displays cliffs of red and green marls, with thinnish beds of black or dark brown, sometimes nodular limestone, associated with which are vast masses of gypsum; the strata very much corrugated, contorted, and broken, especially at the immediate contact with the gypsum, which sometimes contain great fragments of beds of limestone enclosed within the gypseous paste. Towards Woody Cape the high precipitous cliffs consist of green and reddish calcareous sandstone, with greenish, black, and dark blue, frequently nodular limestone and calcareous shales in nearly vertical strata. Fossil shells were found in some of the calcareous beds; calamites and other plants are abundant in some of the sandstones.

Between Woody Cape and Stormy Point the gypseous masses are again brought out on the coast, the strata being sharply folded over and repeated; beyond Stormy Cape the older strata are concealed up to the entrance to the Great Codroy River. In consequence of the numerous folds and repetitions by which the rocks are affected between Cape Anguille and Stormy Point, the thickness of the accumulation remains somewhat uncertain.

On the coast between the Great and Little Codroy Rivers a section of the measures was obtained in pretty regular sequence, consisting of green and red conglomerates, sandstones, red and green marls, and red, green, and black shales, the whole accumulation of which amounted to a thickness of 2306 feet. All this mass of strata is very micaceous, and most of the beds are more or less characterised by the presence of carbonised plants—in some parts the carbonaceous material derived from an accumulation of them being found packed in irregular beds and nests; but in no case did there appear to exist anything like a workable seam of coal.

The course of the Great Codroy River runs a little obliquely across the lower portions of the measures, the calcareous parts with masses of gypsum, coming out on Ryan's Brook a little way back from the estuary; while the limestones were observed on or near the right bank of the river both above and below the falls, and farther on crossing the first fork about a mile and a half above the junction of the streams.

The measures both on the coast and the river sections were found uniformly to dip to the south-eastward (except where a few small disturbances occasion a slight break or undulation) toward the Cape Ray range of mountains, until within a very short distance of the gneiss, where they were usually either highly tilted, inclining in the opposite directions, or vertical. Thus disturbances were visible on the coast near Trainvain Brook, on the banks of the streams near the mountains in the neighbourhood of the first fork, and at the junction of gneiss above the second fork, affording evidence of a great break or fault, which shall presently be more particularly referred to.

The high land of Cape Anguille runs upon the axis of an anticlinal, the north-eastern extension of which is mentioned by Mr. Jukes as crossing the first and second brooks in the country about 3 miles from the coast of St. George's Bay. On both sides of the cape the rocks are disturbed, but are more conspicuously so on the St. George's Bay side, where the cliffs show many complicated contortions; and whether any other formation may protrude through the Carboniferous on or near the crown of the anticlinal arch has not yet been ascertained. Mr. Jukes also mentions the recurrence of the gypseous masses resembling those of Codroy, on either side of the anticlinal on the second brook, and at 8 miles from the coast he states having seen a bed of coal 3 feet thick, which, however, was not traced. At about that distance from the coast there is reason to suspect that the great fault already alluded to may have the effect of cutting off part of that seam, and bringing the lower measures once more to the surface on the south-eastern side.

Evidences of the presence of the gypseous part of the formation were perceived near the base of the mountains a short distance to the westward of the Cairn Mountain, where there are a set of enormous cavities, resembling inverted cones of almost perfect symmetry, sometimes nearly 150 feet in diameter at the surface, with a depth of from 60 to 80 feet to the apex of the cone, in the strike of which some fragments of gypsum were found on the bed of a small brook which falls into Flat Bay Brook just before it enters the gorge of the mountain range. A coarse conglomerate was also observed on this brook associated with bright red marls,

and some small fragments of coal were found strewed at a few parts along its bed and banks.

Coarse conglomerate is exposed upon the banks of Flat Bay Brook dipping irregularly to the eastward, which apparently strikes across to Flat Bay, where, with a north-easterly inclination, it rests upon beds of limestone; and at the mouth of Flat Bay Brook beds of limestone are exposed, with red marls and conglomerate beds resting on them, which dip to the northward.

The mode of occurrence of the lower measures of the formation, with masses of gypsum on the north side of St. George's Bay, were described in the narrative of last year. A fault is there represented letting down a confused mass of Carboniferous limestone among the limestones of Calciferous age inside of Port-a-Port Bay, and a calcareous vein holding galena is represented as indicating the position of the dislocation. The effects of this fault were observed again this season on the outer coast near Red Island, where limestone holding fossils of Carboniferous age were found entangled with Silurian strata, the rocks being thrown down on the northern side, while patches of flat beds (which, however, were not accessible), resting in unconformable relation to the upturned strata of the cliffs, were supposed to be of the same formation. The disturbances which affect the cliffs on the mainland at this part do not reach Red Island, which is of a coarse red conglomerate, with intercalations here and there of great lenticular masses of coarse brown sandstone. The cliffs on the south side of the island attain an altitude of well nigh 300 feet, while at the northern extremity they are not much over 100 feet, showing a gentle inclination very regularly to the northward.

The flat land of the peninsulas between the sea and Port-a-Port Bay was considered from the aspect of the country to be spread over by the arenaceous and calcareous rocks of the lower portions of the Carboniferous formation; but in consequence of the accident to myself, which occurred while on this part of the coast, it was not visited.

At Deer Lake the formation is again recognised on the west side, in some strong beds of coarse conglomerate, dipping at a very small angle to the north-eastward, which line the lake shore, a little way north from the island near the lower end of the lake;

and by numerous large angular slabs of red, green, and brown sandstone which are strewed abundantly on the banks and shores farther up, and are exposed in low cliffs on a brook called Coal Brook, where the strata are nearly horizontal. On the eastern side of Deer Lake the conglomerate is exposed with some beds of limestone at its base, turned up vertically, or inclining at a very high angle towards the lake, striking along the shore and resting against the gneiss of the mountains, the disturbance being evidently connected with a fault running in a north-easterly direction, with a downthrow on the north-west side. Above the forks of the Grand Pond branch the banks expose strata of very bright red sandstone with bright red marls, usually quite or nearly quite flat, until within a short distance of the lower or John's Fall, where the rock consists of brownish and red sandstone in thickish beds, which are somewhat tilted, with a dip towards the north-west. At John's Fall the rock is a coarse conglomerate with red sandstone, the former in beds sometimes upwards of 5 feet thick, which is underlaid by black and greenish calcareous shale. Above John's Fall the banks, which sometimes are upwards of 30 feet high, exhibit black and greenish calcareous and argillaceous shales, interstratified with beds of dark grey nodular limestone, varying in thickness from 1 to 7 inches, in nearly horizontal strata, which continue to be exposed up the long reach at the great bend and on either side of the river to the foot of the upper fall, where they again dip below the coarse conglomerate, inclining at a moderate angle up the river to the north-eastward, showing a flat anticlinal between the two falls.

There appears to be evidence to show that the great fault, of which mention has been made as affecting the strata in the Great Codroy Valley, intersects the island diagonally from shore to shore, running in an almost perfectly straight line from near the entrance of the Little Codroy River to White Bay.

The coal rocks were perceived to be disturbed along the base of the Cape Ray mountains, wherever visited, from Trainvain Brook to the upper forks of the Great Codroy, at the base of the hills near the Cairn Mountain, on the east side of Deer Lake, and near John's Fall on the Humber; while the Silurian limestones at the head of Spruce Brook, which are directly in the line of the dislocation, are much disturbed, and the coarse conglomerates of Miller's Island

and the western shores of White Bay are turned up vertically. The value of this fault was not accurately ascertained, but as in some parts, as at Trainvain Brook, it seems to bring up strata low down in the coal formation against measures which may be assumed to be 3000 feet higher in the formation, it may be equal to that amount, and probably more.

I have been thus particular in describing this dislocation, not simply as a feature of great geological importance, but as materially affecting the probability of workable seams of coal being found to exist in the coal measures of the interior. There is no doubt a very considerable breadth of country spread over by coal measures between Sandy Pond on the one hand and Adie's Pond and the Laurentian mountains on the other; but the strata being mostly flat, as has been shown in the valley of the Humber, and an upthrow fault occurring on the Sandy Pond side of the trough bringing lower measures to the surface on the eastern side of the dislocation, it is not unreasonable to infer that the whole or greater amount of strata consists of lower members of the formation, in which, so far as at present known, seams of workable coal do not appear to exist.

Economic Materials.

The economic materials observed during the season, at various parts, were copper, lead, iron, plumbago, building stones of granite, sandstone, and limestone, limestone for burning, whetstones, black, white, and variegated marbles, serpentine, gypsum (white and grey), red ochre, shell marls, peat, and clay.

Copper Ore.

A beautiful sample of vitreous grey copper ore was obtained from Rock Cove, near Grandy's Point in Placentia Bay, which appears by the description given of the locality to run in veins; and indications of similar ore, together with native copper, are reported to exist at various parts in Fortune Bay: copper was also observed associated with other minerals at the La Manche mines in Placentia Bay. At this place it is chiefly indicated by the presence of green carbonate of copper diffused through the calcareous matrix of the vein, and nodules of malachite occur usually near the walls of the lode.

*Lead.**

Crystals of galena were observed in quartz veins, cutting the gneiss of the island, on Deer Lake, and on the point of the mainland opposite. The rock at this part is chiefly mica-slate, constituted for the greater part of fine grains of white quartz and small scales of silvery mica; small coarse garnets and cubical iron pyrites are sprinkled through the mass in abundance. The strata are cut by numerous veins of semi-translucent white quartz, the largest of which is about 3 feet wide, running in a north and south direction, with numerous smaller veins radiating from it east and west. A few specks of galena were observed in the main vein, but it was chiefly in the smaller ones that the ore seemed to occur.

At Parrody's Head, near the head of the Bay D'Espoir,† galena was found in white quartz veins through which calc-spar is disseminated, but not in large proportion. These veins run irregularly, intersecting black, plumbaginous, occasionally slightly calcareous slate, which was supposed to be of Lower Silurian age, and is the rock of the country over a very large area of the surrounding region.

The La Manche mine is situated near the north-eastern extremity of Placentia Bay, between Little Southern Harbour and Little Bay. The vein that is worked for lead varies in width from 3 to 6 feet, and is chiefly of calc-spar, much of which is tinged of a pale pinkish amethystine colour. Sulphate of barytes, quartz, and fluor-spar are more or less distributed through the vein, the walls of which are frequently lined with beautiful crystals of amethystine quartz, and occasionally with green or blue malachite.

The ore is distributed irregularly through the whole thickness of the vein, sometimes in "voughs," as termed by the miners, or pockets; but there appears to be also a pretty regular and continuous string of ore near the middle of the lode, of from 1 to 4 inches thickness, from whence the "prill ore," as it is termed, is derived. The run of the vein is about N. 63° E. from the water's edge, and its attitude vertical, maintaining that course and attitude with great regularity, and being traceable on the surface for a

* Molybdenite also occurs at Deer Pond, which sometimes has been mistaken for an ore of lead.

† The original was a French word "D'Espoir," or "The Bay of Hope," which has been corrupted into "Despair" by the English.

considerable distance. The lode cuts a set of green, very hard and brittle, compact, cherty or jaspery slates, which cleave exactly with the bedding and for the most part weather an opaque white, which discoloration extends into the stone for an inch or more. The dip on the south-eastern side of the lode is about N. 27° W. $< 25°$; that on the north side points in the same direction, but with an increased rate of inclination. From the position of the vein to the entrance of Little Southern Harbour, the measures gradually accumulate upon this dip, but as there are several dislocations observed in the cliffs it is probable the same strata may be repeated. A considerable amount of red strata are visible in the cliffs, of a hard jaspery character, alternating with rock of a dark bottle-green colour, having the aspect of diorite; but being incapable of landing to examine that part of the coast, I am unable to state the mineral characters with certainty.

It will require much further investigation to determine with any amount of certainty the geological horizon which these rocks may represent; but it may be stated that the mineral character and general aspect of the strata bear a very strong resemblance to the rocks at the Topsail cliffs in Conception Bay, where the evidence tends to show that rocks of Lower Silurian age succeed them unconformably. Indications of lead ore, moreover, have been perceived near the coast between Topsail Head and Portugal Cove; and more recently the same ore has been found in veins intersecting the slates and sandstones in the immediate vicinity of St. John's.*

Iron.

Near the junction of the coal measures with the gneiss on the Great Codroy River some bands of a very ferruginous character were observed, interstratified with the latter rocks. These bands are of a reddish-brown colour, hard, brittle, and with a conchoidal fracture, the broken surfaces presenting occasionally a metallic lustre.

Much of the gneiss in this locality is of a bright red colour, which is derived from the prevalence of bright red orthoclase feldspar over the other constituents, which consist of small grains of semi-translucent white quartz and small scales of mica.

* I was informed at the La Manche mines that the amount of ore shipped during the years 1858–59 amounted to 2,354,987 lbs., or 1051 tons.

In this locality, and for some distance down the stream, large slabs and fragments of pure white crystalline limestone, with specks of graphite and silvery mica, were observed to occur in abundance, from which circumstance it was assumed that strata of that character must rest *in situ* somewhere among the Laurentian rocks farther in the interior.

Some beautiful specimens of magnetic iron ore were procured from the neighbourhood of the Cairn Mountain near Flat Bay Brook, which, judging from the quantity distributed over the surface of the ground, is probably derived from a large and important mass in that neighbourhood. The rocks with which the ore seems to be associated are of an opaque white colour, for the most part, being chiefly composed of white feldspar with quartz, in a small proportion, and labradorite.

Plumbago.

This mineral was found to be pretty generally disseminated in a set of black shaly slates on the islands and main shores towards the head of the Bay D'Espoir. On the north side of Richard's Island it has been taken out in considerable quantities by the neighbouring residents for usual household purposes, and it was observed to occur in the same rocks on the banks of the brook by the Indian settlement, at the entrance to the Conne River. The mineral appeared to be in the greatest abundance where the strata were affected by cracks or dislocations, which, on Richard's Island, Isle Bois, and the northern side of Long Island, are of frequent occurrence. The age of these plumbaginous slates is doubtful, but it was considered probable will prove eventually to be Lower Silurian, and may be the equivalent of the slates and shales of Manuel's Brook and the islands of Conception Bay.

The slates in Bay D'Espoir are usually more or less calcareous, and are intersected by veins of both calc-spar and white quartz.

They usually display a fibrous structure with a silky glistening surface, sometimes covered over by remarkable crystals, and abounding with decomposing iron pyrites.

Gypsum.

Gypsum abounds in the lower part of the Carboniferous system, and is largely developed on the coast near Codroy and in the Bay

St. George. The vast masses which come out in the cliffs between Codroy Island and the Great Codroy River can hardly fail to prove some day of very great value and importance. The colour of the greater portion of the masses on the Codroy side of Cape Anguille is grey, and usually presents a regularly laminated appearance by the presence of thin scales of a black substance which alternates with the soft white gypsum; but there are portions very white also, and the associated marls are frequently streaked with thin seams of snowy fibrous gypsum. The little harbour on Codroy Island is a sufficiently favourable shelter for small vessels, and the Codroy Roads, having a fair anchorage for larger sized craft outside during the summer months, there does not appear to be any great difficulty to overcome in having these great deposits opened out to commercial enterprise. Large quantities of gypsum are annually taken for the Lower Canada market from the Magdalene Islands, where probably the facilities for working the material are not greatly more favourable than in this part of Newfoundland.

The great mass of gypsum at the entrance to Romain's Brook was described in the narrative of last year's exploration. It is chiefly pure white, and is admirably suited for stucco purposes; but the want of shelter for vessels at that part, offers a considerable obstacle to the shipment of the material. The gypsum of the south coast of St. George's Bay and in the interior I had no opportunity of visiting.

Marbles.

The fossiliferous limestone of Topsail Head takes a high polish and affords a very handsome description of variegated marble, some cubes of which were sent to be shown as specimens at the ensuing exhibition at Paris. Some of the variegated red and white beds of limestone near Cape St. George are likely to yield a good and ornamental material; and one strong, pale drab-coloured bed which comes out in the cliffs nearly opposite Red Island is particularly fine in grain, takes a very high polish, and might be taken in blocks of any size under 5 feet in thickness. This bed seems to be of very pure lime, and is sometimes upwards of 7 feet thick. The position of this stratum of rock, however, cannot be said to be favourable, as the only anchorage near is under the beach at Red Island,

which affords shelter from northerly winds only; but as it strikes inland and probably runs across to the Port-a-Port side of the peninsula, it is possible enough some parts may be found where it might be quarried to advantage.

Marbles of various kinds occur at certain parts of the Bay of Islands. The cliffs at the entrance to the Humber River yield white, black, and variegated red and white limestone, a large portion of which is capable of being used for many ornamental purposes, although, so far as I have yet been able to ascertain, the white variety seems usually to be too coarsely crystalline for statuary purposes. Just below the lower rapids a vein of compact calcareous spar between 2½ and 3 feet wide may be seen on the right bank of the river, cutting the strata and running up the face of the cliff with great regularity, and many more similar veins occur on both sides, both above and below. Some white and variegated marble has been obtained from this large vein, which, although susceptible of receiving a smooth surface, is mostly too coarse in texture to be considered of high quality as an ornamental stone; but I am informed by Mr. Makim of this place that higher up the hill, near where this vein comes out, a pure white marble may be obtained from beds which may prove to be of more importance. Some beds of black limestone of very fine grain, hard and compact, the exposed surfaces of which are sometimes characterised by obscure silicified organic remains, occur also in the lower reach of the Humber River, which are capable of receiving a fine polish; and at a place called Cook's Cove, on the south side of the Humber Arm, a beautiful and homogeneous sample of jet black marble was obtained from a bed about 6 inches thick, and in immediate contact with a conglomerate limestone.

Still another variety of marble may be found at York Harbour, where a great mass of serpentine, which forms an adjacent range of hills, comes to the water's edge. Some specimens were obtained from this locality, and sent with others of the collection for exhibition; but as these were derived from broken fragments of the exposed outcrops, they can hardly be taken as fair samples of the general quality of the rock. The colour is a dark bottle-green, with black and sometimes white streaks; but the rock being brittle and a good deal shattered, probably by the influence of the weather, the surfaces polished were not very satisfactory. A

beautiful specimen of serpentine, however, was produced for exhibition by C. F. Bennett, Esq., from Little Bay, near the Terra Nova mine.

Building Stone.

Granite.—A very coarse, dark reddish granite occupies a considerable portion of the coast at La Poile, the prevailing colour being derived from large irregularly-formed crystals of red feldspar, which usually give the exposed surface the aspect of a conglomerate when viewed at a little distance. A finer-grained quality of granite is found to intersect the coarse mass, sometimes of a red and at other times of a whitish-grey colour. The coarse variety is very hard, tough, and endurable, and would doubtless have a grand and imposing effect in large and massive structures. The age of the coarse-grained rock is undetermined; the intersecting veins, however, penetrate into a set of blackish or dark blue and greenish slates, which come against the granite at Little La Poile, indicating a more recent origin than the slates, which are probably Lower Silurian. An exactly similar coarse granite was observed in 1864 at the other extreme of the island, at Cat Cove, near Cape Freels.

A beautiful variety of granite occurs at Rose Blanche, where there is an excellent small harbour, about 12 miles west from La Poile. The colour of the rock is of a whitish grey, it is rather fine grained, and is constituted of white quartz, white feldspar, and brown mica. Blocks of this granite are easily procurable in almost any requisite size all along the shore, and in inexhaustible quantity.

Sandstones.—A good material for building may be procured in ample abundance from the sandstones of Kelly's Island, in Conception Bay. The stone is usually of a greenish tinge, sometimes weathering yellowish; some beds are very hard and difficult to dress with the hammer; others are freer in the grain, and dress with facility. The sandstones of Kelly's Island rest upon a set of brownish shaly slates, and beds of that description are interstratified with them. Portions of the measures are slightly calcareous, and most of the sandstones are somewhat micaceous. The horizon of these rocks, together with the slates and limestones of Manuel's Brook and Topsail Head, is supposed to be low down in the Silurian system.

Admirable building stone is obtainable at many parts from the

sandstones of the Carboniferous rocks, instances of which may be specified as occurring on Codroy Island, in the section between the great and little rivers Codroy, and on the Great Codroy River. The rock on Codroy Island, where the bands are thick, is frequently slightly calcareous, and is very hard and compact, the centre part of the bed being of a pale bluish grey on fracture, while the exposed surfaces weather of a drab or yellowish colour. Some of the beds south of Codroy River are a drab freestone slightly coarse in grain, and always more or less micaceous, yielding a handsome material which is easily worked. Beds of this description were also observed in several parts on the banks of the Great Codroy River.

Whetstones and Grindstones.

Some of the sandstone beds of the coal formation on the Great Codroy River, near the falls, and at one or two places in the coast section, would produce good scythe stones; and near Cape Anguille, pieces of a slightly calcareous slate of the very finest texture, very hard and of a dark grey colour, were found, of excellent quality as hones for knives, and are probably well adapted for finer tools or instruments. Many sandstone beds of the coal measures might be used for grindstones. Some of the best hitherto observed were found on the Grand Pond, near the foot of Old Harry Mountain; while at Whetstone Point, on the opposite side of the same lake, scythe and coarse hone-stones in unbounded quantity may be picked off the beach or worked out of the adjacent cliffs.

Limestones.

The cliffs of Cape St. George and the coast north from it are apparently more or less magnesian in quality; but beds occur of very pure lime at some parts, among which may be enumerated, in particular, the pale drab stratum, already alluded to under the head of marble. Some of the dark-coloured bituminous and fossiliferous beds of the Calciferous formation, such as those that skirt the coast inside the isthmus of Port-a-Port, are no doubt of good material for burning.

Many beds in the cliffs of limestone at the entrance to the Humber River, which are supposed to be chiefly of the Calciferous age, may be found to possess all the requisites for burning into

lime; and some of those which outcrop in the Humber Arm at Cook's Cove and other places, associated with limestone conglomerate, may also be found available for the same purpose.

The limestone beds in the lower coal measures also are probably in many instances well adapted for making good lime, examples of which may be instanced as occurring on the coast near Codroy, and thence cropping out at intervals near the right bank of the Great Codroy River, particularly at Ryan's Brook, where there is a considerable thickness of this rock exposed, with sandstone and masses of gypsum.

A limestone occurs at the entrance to Ship Cove, at Burin, on the west side of Placentia Bay, which was supposed to be the equivalent of the rock of Topsail Head, and very low down in the Silurian system. It occurs in two bands, one from 15 to 20 feet thick, the other from 30 to 40 feet, divided by black calcareous shales, and overlaid by similar shaly and slaty strata, containing a brown material supposed to be an oxide of manganese, with which the surrounding parts are discoloured. The colour of the limestone on fracture is pale blue, weathering drab on the exposed surfaces, some of which exhibit obscure forms supposed to be organic, probably fucoids. This rock has been quarried to some extent, for the purpose of burning into lime.

Red Ochre.

This material is derived from the red marls of the coal measures, and has been frequently used by the inhabitants near the coast of St. George's Bay, as a red paint and as red chalk. It was observed upon the banks of the Flat Bay Brook, and on the Humber River above Beaver Pond. It is also reported to be found on the banks of the brooks between Flat Bay and the high land of Cape Anguille.

Clay.

At the extreme head of the Bay D'Espoir, at the entrance to the Conne River, there is a deposit of stiff blue regularly stratified clay, apparently quite free from lime, which probably may be found fit for the manufacture of either common or fire bricks, and possibly for some pottery purposes. A rude attempt was observed to have been made to burn bricks upon the spot, which did not

appear to have been successful, probably in consequence of want of proper appliances. When burned it becomes an Indian red colour.

Shell Marl and Peat.

Peat is extensively spread over the flat country of the Codroy most of the way, and at Capelin Cove it forms the upper part of the bank in a thickness at some parts of 5 feet or more, resting upon a bed of shell marl, which in its turn is underlaid by another bed of peat from 6 to 10 inches thick. The shore banks between Flat Bay and the Gut also are capped with peat, and the same is probably the case over a great part of the flat coal measure area, which has not been visited. The value of this substance as a fuel need not be commented upon.

A deposit of fresh-water shell marl was observed on the coast of St. George's Bay, between Romain's Brook and the isthmus of Port-a-Port, about half a mile from the former. The deposit is not very extensive, but of considerable thickness; it is white, and contains Planorbis and other fresh-water shells, and rests on a bed of seaweed about 18 inches in thickness, which reposes on clay with pebbles and small boulders. The bottom of the bed of seaweed is about 12 feet over high-water mark. Shell marl is useful as an agricultural manure, and when sufficiently pure answers a good purpose as a whitewash.

Ornamental Stones.

Red, and green, and brown jaspers were frequently found on the shores of the Humber Arm, and in the valley of the Humber River; they were also observed in sundry places in St. George's Bay and on Flat Bay Brook. These probably take their origin in beds or veins of Lower Silurian age, but frequently occur as smoothly rounded pebbles in the conglomerates of the coal measures. The red jaspers in particular are frequently capable of taking a high polish, and might be cut into brooches, seals, and other personal ornaments.

The labradorite of Cairn Mountain, some cleavage planes of which are opalescent, reflecting various beautiful colours when placed at a certain angle to the rays of light, may in some cases

be found as a handsome ornamental material. Its prevalent colour at this part is a pale yellowish white.

The malachite found lining the walls of the vein at the La Manche mine, as far as my present information goes, has only been found in small quantities.

Petroleum.

This substance was reported as existing on Middle Point of Port-a-Port in my narrative of last year. Since then a sample of oil has been procured from the spot by C. F. Bennett, Esq.; but having been unable to visit that part, I can give no further particulars as to the mode of its occurrence. Petroleum is now stated to have been discovered in the neighbourhood of Bonne Bay; but not having visited the locality, I am still ignorant of the conditions under which it is produced.

Quartz Veins.

Samples were taken of quartz veins from Deer Lake, Humber Arm, and Bay D'Espoir, which have been forwarded to Montreal for chemical analysis, the conditions under which they were found to occur giving reason to presume the possibility of some trace of the precious metals being discovered.

I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY,

Geological Survey.

To His Excellency Anthony Musgrave.

CHAPTER VI.

MINERAL RESOURCES OF NEWFOUNDLAND: ADDRESSED TO W. C. SARGEAUNT, ESQ., CROWN AGENT FOR THE COLONIES, SPRING GARDENS, CHARING CROSS, LONDON, AND PUBLISHED IN THE 'JOURNAL OF THE SOCIETY OF ARTS,' OCTOBER 11TH, 1867.

THE following Report on this subject has been addressed to the Crown Agent for the Colonies:—

SIR,—A copy of a correspondence between his Excellency A. Musgrave, Governor of Newfoundland, and the Crown Agent for the Colonies, in London, has been placed in my hands, relating to the mineral resources of that colony, it being the purpose of the authorities to bring certain portions of country where minerals are supposed to exist to public sale.

As I have been engaged for the last three years in making a geological survey of Newfoundland, and have during that time explored a considerable part of the island, the local government have been pleased to direct me to express my views on this matter, so far as my present information will permit, in answer to certain queries made in a letter to his Excellency the Governor, from Mr. W. C. Sargeaunt, Crown Agent for the Colonies, dated the 30th March, 1867.

It may be well to premise these remarks by stating that in a wild and unknown country there are many and serious difficulties to contend against while working out the structure and distribution of the geological formations, and ascertaining their several characteristics, mineral and fossil; and that while pursuing these duties it would be utterly impracticable for the geologist to devote such time, labour, and expense upon any one particular spot or even locality as would be required for the development of ores or minerals with a view to practical mining; yet in carrying out such an investigation there is no doubt a great amount of information may be acquired in a great degree important to mining adventure.

It is greatly to be regretted by all who have the interests of the province at heart, that grossly exaggerated statements, referring to the mineral wealth of Newfoundland, have at various times been circulated in a manner which has tended to retard rather than advance the object desired, propounding assertions too palpably improbable to admit of any consideration on the part of experienced persons. Nevertheless, there can be no doubt that the mineral indications in many instances are highly encouraging, and may ultimately prove of great importance to the colony.

The mineral productions which have been discovered at various times on different parts of the island are the ores of silver, copper, lead, iron, and manganese, with white, black, and variegated marbles, large masses of gypsum in the Lower Carboniferous formation, plumbago, and petroleum. Peat and shell marl abound at many parts on the surface.

A large tract of country is spread over by rocks of Carboniferous age, but it is still doubtful whether they contain seams of coal sufficiently thick to be of commercial value. There are but three places, that I am aware of, where mining has been seriously attempted, viz., the "Terra Nova" mine, in Little Bay or Bay Vert; the "Union" mine at Tilt Cove, in Notre Dame Bay; and the "La Manche" mine at the head of Placentia Bay.* Copper ore in association with iron pyrites is produced at the two former of these locations, galena or sulphuret of lead from the latter; and as the work done at these places may to a certain extent afford an index to future similar operations, I shall endeavour to give my views respecting the geological horizon to which they belong, and the mode of their occurrence.

The tabular arrangement given at pp. 49–50 will explain the relation and succession of the formations.

It will be seen by reference to the table that the Quebec group is fully developed in Newfoundland, and there is no doubt it is characterised in many respects by similar qualities to those displayed in the same formation in Canada. It is in the Lauzon division of this group (No. 7 of the table) that the ores of copper

* Small openings have been made at a great number of places where metalliferous indications presented themselves, but the work done at those parts has been too limited to be properly designated as mining.

have been hitherto chiefly observed, and it is in the same part of the formation that the two openings before referred to are situated. Dr. Sterry Hunt, of the Geological Survey of Canada, in a pamphlet published in the 'American Journal of Science,' in May 1861, expresses his views regarding the economic importance of the Quebec group in the following words:—

"This Quebec group is of considerable economic interest, inasmuch as it is the great metalliferous formation of North America. To it belongs the gold which is found along the Appalachian chain from Canada to Georgia, together with lead, zinc, copper, silver, cobalt, nickel, chrome, and titanium. I have long since called attention to the constant association of the latter metals, particularly chrome and nickel, with the ophiolites and other magnesian rocks of this series, while they are wanting in similar rocks of Laurentian age. The immense deposits of copper ore in East Tennessee, and the similar ores in Lower Canada, both of which are in beds subordinate to the stratification, belong to this group. The lead, copper, zinc, cobalt, and nickel of Missouri, and the copper of Lake Superior, also occur in rocks of the same age, which appears to be pre-eminently the metalliferous period."

A perusal of the survey of the Union mine will explain the conditions under which the ore occurs, and the relation the cupriferous strata bear to the serpentines; while the plan of the works and the accompanying section will show the actual progress made nearly up to the present time.* Operations were first commenced at this place in 1865, during which year about 500 tons of ore were extracted, varying in quality from 7 to 23 per cent. of copper. In 1866 about 2500 tons of ore were brought to the surface, which was divided and classed according to quality, as No. 1 and No. 2 ores. An analysis by Bath, of Swansea, of some good average specimens of this ore is said to have yielded from 17⅝ to 21¼ of copper. About 120 men of all classes have been recently employed at these works.

An extract from a narrative of my own proceedings during the year 1865, addressed to his Excellency Governor Musgrave, expresses my views as to the probable mode in which these ores

* These plans accompanied the original paper, and are deposited in the Crown Lands Office, St. John's. They are since superseded, however, by plans of more recent date.

will be found to occur in this formation generally, and at this place in particular (see p. 54).

The experiment of the Union mine has, so far as it has yet gone, proved eminently successful, and as the indications on the east side of Winser Pond exactly correspond with those on the west side, where the work is proceeding, it is but reasonable to infer that a vast amount of ore may be extracted from the same deposits beneath the pond, and farther on in the strike on either side.

At the Terra Nova location the experiment of mining has not hitherto proved remunerative, but its position in relation to the serpentine may be regarded as favourable and worthy of more extended trial. The metalliferous stratum upon which the principal shaft has been sunk, and upon which the drifts are driven, appears chiefly to consist of an enormous mass of iron pyrites, with an occasional admixture of yellow sulphuret of copper. Native copper has been observed occasionally in small quantities among the serpentine. Reference to the plan* will show that the mining done up to the end of last year is confined to a small space, and that the ground is by no means thoroughly proved, although a very large amount of labour and expense has been bestowed upon the surface.

From what has been stated above, therefore, it will be evident that the distribution of the serpentine is a matter of high importance to those interested in the discovery of metalliferous ores, and, as the formation of which it forms a part is largely developed in various parts of the island, there is good reason to anticipate that Newfoundland will become, in course of time, a great field for mining industry. The serpentine is largely developed on the north side of Hare Bay, and between that bay and Pistolet Bay; it occurs also in great extent on the west side of the island, at York Harbour in the Bay of Islands, and from the northern arm of that bay to Bonne Bay.

From the evidence procured from Topsail Head, in Conception Bay, there appears to be a great series of strata of more ancient date than the lowest Silurian and newer than the Laurentian, consisting of slates, with interstratified bands of quartzite, diorite, and jaspery beds, the latter often of a red colour, with a mass of red or

* With original paper.

grey altered sandstone and conglomerate at the summit. These rocks are intersected by numerous veins, most frequently of quartz, but in many cases of calc-spar, or a mixture of the two, which occasionally contain the ores of lead, sometimes associated with silver and copper. The rocks of the La Manche locality will probably prove to belong to this series, but the formation has as yet only partially been followed out. As regards the mine, circumstances at the time of my visit to the latter place unfortunately prevented me from making a thorough examination of the ground, and such information as I was able to obtain is given in a preliminary report of mine, addressed to his Excellency on the 1st March last (see p. 92).

Indications of lead ore are of frequent occurrence at many parts where rocks supposed to be of the same horizon display themselves, as in the cliffs of Topsail Head, at Cape Chapeau Rouge, at Lawn, where some beautiful samples of silver ore were likewise discovered, and in the harbour of St. John's itself, facts tending to induce the belief that mineral treasures may reasonably be expected, in course of time, to be brought to light. Veins containing lead, however, are apparently not confined to any particular formation; the presence of that metal has been observed as low as the Laurentian, and as high as the coal measures; but whether the veins holding the ore are of one or different ages has not been ascertained. One vein, which appears to be more recent than the Lower Carboniferous, and is mentioned in the narrative of my expedition in 1865, appears to be worthy of trial (see pp. 68–69).

Respecting the presence of the precious metals in the island, little is at present known. Some beautiful small specimens of a pure sulph-arseniuret of silver, usually called ruby silver, yielding on analysis 65·28 per cent. of the metal, and encrusted with chloride of silver, known as horn silver, were discovered some years ago at a place called Lawn, on the south shore, not far from Cape Chapeau Rouge; and small specks of gold have been exhibited, which were said to have been derived from a vein of quartz near Ming's Bight, on the north-east side of the island. During the past season, several samples of quartz veins were procured by myself, where the probability of the precious metals was suspected, and some were forwarded to Montreal for analysis, the result of which is given below, with each locality.

Supposed Laurentian.

Quartz, with iron pyrites visible, from Deer Lake, Humber River	Silver, 0·0205 per cent. Gold, none.
Quartz veins on the island, Deer Lake, ditto	Silver, 0·0060 " Gold, none.
Quartz veins from the south shore of Deer Lake ..	Silver, 0·02633 " Gold, none.

Lower Silurian.

Quartz and calc-spar veins from Brake's Landing, at the entrance to the Humber River	Silver, 0·01033 " Gold, minute traces.
Quartz veins from Meadow Point, Humber Arm, Bay of Islands	Silver, 0·00666 " Gold, traces.
Quartz veins from calcareous slate, from Cook's Cove, Humber Arm, Bay of Islands	Silver, 0·00833 " Gold, traces.

(Signed) E. J. Blackwell,
For G. P. Girdwood, Assist.-Chemist, Montreal.

It will be seen that the presence of silver is indicated, to a small extent, in all these samples, while a trace of gold is detectable in each of the veins cutting Lower Silurian strata; none whatever in those intersecting the Laurentian.

Gypsum is largely developed on the western side of the island, among the lower members of the Carboniferous system; there is a vast exposure of that mineral on the coast between Codroy Island and the Codroy River, where it might be quarried to any extent, while there is a moderately good harbour for small vessels in Codroy Island. The same mineral occurs at various parts of the coast in St. George's Bay, on both the north and south sides, but those parts are usually rather unfavourable for vessels lying safely at anchor, although frequent opportunities may be had during the summer months for taking in cargo. At Romain's Brook, on the north side of the bay, there is a large exposure of gypsum, much of which is very pure white, and will probably be found to be well adapted for stucco purposes.

Besides the metallic ores and the more valuable substances, the island abounds in material of great economic importance. Marbles of almost every shade of colour have been produced from various parts of the coast, on both the eastern and western shores. Roofing slates of excellent quality are already known and partially worked in Trinity Bay. Plumbago occurs in the Bay of D'Espoir. Indications of petroleum have been observed at a few localities, while

building stone, whetstones, grindstones, and limestone are in ample profusion.

Notwithstanding the usually very forbidding aspect of the coast, there is clearly a large proportion of the country perfectly capable of being reclaimed, and converted into fairly productive grazing or arable land. The most favoured tracts that have yet come under my own observation are in the coal measure districts, where the surface is often flat or gently undulating over great areas. In my Report of last year, 1866-67, I have shown, by a rough calculation, that there are probably about 726 square miles, or 446,080 square acres, more or less available for settlement on the carboniferous country of the western part of the island alone, which embraces the following districts :—

	Sq. miles.		Sq. acres.
Codroy Valley	75	=	48,000
St. George's Bay	222	=	142,080
Humber River	429	=	256,000
Total	726	=	446,080

These valleys are for the most part well wooded, producing in many instances large pines, juniper, or tamarack (the latter a species of larch), fine yellow birch, and other valuable timber. In the valley of the Humber this is especially the case, where a large area of country appears to be provided with all the necessary material for ship-building in a remarkable degree.

With the exception of two inconsiderable rapids, there is no obstruction to the navigation of the river by large boats for 32 miles up its course, where timber of the various species is amply abundant (particularly at Deer Lake, and between it and the Grand Pond Forks), which might be procured without difficulty. Above the forks of the Grand Pond branch, the streams in each instance become very rapid, but canoes have frequently navigated them both up and down. A comparatively easy route may be travelled across the island by following the southern stream to the Grand Pond, and thence to its main sources, while a " portage " of a few miles from Birchy Pond (one of the head lakes of the Grand Pond branch of the Humber) will reach the waters of the Indian Brook, which flows into the sea at Hall's Bay, on the eastern side of the island, and is only interrupted in its course by one small fall, about 3 miles above the outlet. The northern branch of the

river is also accessible for canoes, and at one part, where its upward course bends round to the westward, the distance to be travelled to the head of White Bay is within 10 miles.

The construction of a few main lines of road, for which (with the exception of about 3 miles at the mouth of the Humber) the whole of the Humber region offers considerable facilities, together with the natural means of communication by water, might be made to open up a thriving settlement through the very heart of the island.

With regard to water power as a means for working machinery, the physical character of the country is such that it can be obtained at nearly every part in unlimited abundance. Ponds and lakes are dotted over the surface of the country to such an extent that it may be doubtful whether the superficial area covered by water is not equal to that of the land, and many of them, being at a great elevation, give rise to innumerable mountain torrents, which give their tribute to the main streams in the valleys at short intervals between each other.

The climate of Newfoundland is not by any means so severe as is generally supposed. The range of the thermometer is very much less than it is in any part of the Canadas, the heat in summer seldom exceeding from 70° to 75° Fahr., while the cold in winter is seldom very much below zero. The fogs, generally supposed by those unacquainted with the country to envelope the whole island almost eternally, have but a limited existence in the interior, and are not by any means prevalent on the northern or western shores, although they certainly prevail on the southern shores generally, and at Placentia and Trinity Bays particularly.

Provisions have hitherto been chiefly supplied from Halifax or Prince Edward's Island; but should mining and agricultural pursuits combined be once fairly established, I see no reason to doubt the capability of the island to raise all the necessaries of life for its inhabitants.

I have the honour to be, Sir,
Your obedient servant,
ALEXANDER MURRAY.

W. C. Sargeaunt, Esq.,
Crown Agent for the Colonies,
Spring Gardens, Charing Cross, London.

The following extract, from a letter written by Mr. Murray, on the 10th September last, and dated Union Mine, Tilt Cove, Newfoundland, gives more recent information :—

"The prospects of the mine are of the most highly encouraging nature, and as it may be of importance that the truth should be known in England, I should like my opinion of the matter published in the 'Journal,' as a rider to my letter to Mr. Sargeaunt.

"The production of copper ore from the commencement of the present year has been as follows :—

	Tons.
The amount of ore accumulated during the winter of 1866–67, and shipped for Swansea, up to the 1st August, 1867	2200
The amount of ore on the floor ready for shipment	880
Ore ready in the mine	500
	3580

And if the necessary shipping is supplied, the total amount of ore exported for the season will not be less than 4000 tons. In working out this, the masses of ore have in no one case been exhausted, but simply driven through and the material extracted from the drifts; the experiment of proving the ground being carried on all the time, and constantly exhibiting new and most important masses; and I have no hesitation in stating, from my own personal observation of all the circumstances, that the ore now in sight is sufficient in itself to keep up a supply, at least equal to that of the present season, for several years to come.

"I consider that the facts, which are indubitable, of the success of this mine ought to be of such interest to capitalists as to induce many to venture on similar experiments in different parts of this island, where the geological conditions are similar or identical; but I would recommend at the same time that great care should be taken to be assured of the said geological conditions, as many metalliferous indications occur at parts where, so far as I can judge, they are of little importance, although ignorant and interested parties abound who will unhesitatingly give most exaggerated statements without the slightest foundation in fact."

CHAPTER VII.

REPORT FOR 1867.—SURVEY OF TILT COVE AND THE NEIGHBOURING COUNTRY, ON NORTH SHORE OF NOTRE DAME BAY; WITH A DESCRIPTION OF THE UNION MINE, &c.

MAY IT PLEASE YOUR EXCELLENCY,—

On my return from England last August, you were pleased to suggest that I should employ the remainder of the season in extending the geological investigations previously made in 1865, of the region in the immediate neighbourhood of the Union Mine, Tilt Cove, in order to develop the general stratigraphical character of that part, and to ascertain as far as possible the run of the formations with which the mineral is associated. In accordance with this suggestion, after a few days' detention at St. John's in making preparations, I proceeded to Tilt Cove by the steamer *Diamond* (by which vessel the Government were pleased to order me a passage), and immediately commenced operations by making a minute examination and survey of the Union Mine and the lands adjacent to it.

In carrying on those duties I was very materially aided through the kindness of Messrs. C. F. Bennett and Smith McKay, the proprietors of the Union Mine, who not only permitted me to inspect the whole of the works with the utmost minuteness, but rendered me every assistance in procuring such labour as was from time to time required, and most particularly by permitting Mr. Thomas Long, the manager of Mr. C. F. Bennett's mill business, to act as my assistant while surveying the immediate neighbourhood of the mine; and I now beg to be permitted thus publicly to acknowledge my obligations to those gentlemen for their attention and liberality. I also beg to call attention to the very creditable manner in which Mr. Long has executed the drafting of the maps I now submit for the inspection of your Excellency and Council, taken from the surveys made by myself in the field.

In consequence of the great amount of work that had been

accomplished at the Union Mine both underground and on the surface since my last visit to that location, I found it necessary to make a complete revision of my former survey; and the plan which I have now the honour to submit, will be found in consequence to be considerably modified upon the one of 1865, and a few minor inaccuracies corrected. The present plan is laid down upon the same scale as that of 1865, namely, 4 chains to 1 inch; and is constructed to embrace the surface area lying between Beaver Cove Pond and Beaver Cove on the east, and a sheet of water called Castle Rock Pond on the west; while latitudinally it lies between a range of hills that run on the north side of all those ponds and the sea. In linear measurement the distance is about 164 chains longitudinally, and the average breadth, without including the northern highlands or any part of the sea margin, may be taken at about 48 chains, giving an area of a little over 1¼ square mile; running on the general course of the mineral-bearing portion of the formation.

The large map is drawn on a scale of 4 inches to 1 mile, extending along the coast line from La Scie round Cape St. John to Nipper's Harbour. The coast is taken from the published charts of that part, enlarged to suit the scale; the plans included therein are the result of my season's survey. The latter includes a suite of small lakes lying rudely parallel to the coast; the survey of which with the surrounding country was connected by triangulation and careful measurement from Beaver Cove Pond to the western extreme of Red Cliff Ponds, immediately in the rear of Snook's Arm; giving a linear distance of about 7 miles, with an average breadth from the sea of about 2 miles, and including an area of nearly 14 square miles. Upon the same plan will be found a description of the rocks crossed on the path between Shoe Cove and La Scie, with some detail of the geological features observed in the vicinity of the latter place, while such facts as it was possible to ascertain upon the coast are represented as far as Nipper's Harbour, where my examination terminated.

Union Mine, Tilt Cove.

As this mine may be taken as an example of what the mineral products of the island may prove to be at other parts, as also being an illustration of the success that frequently attends a

combination of bold enterprise, great perseverance, and judicious management, a good deal of time and study was bestowed upon the location in order to arrive at as perfect a knowledge as possible of the mode in which the metalliferous ores occur and the sequence and character of the rocks with which they are associated. This could only be accomplished by carefully surveying and planning the place in all its parts; and I trust that the plan which accompanies this Report will, with the following description, be found sufficiently explicit and intelligible, to convey to those interested in mining adventure an adequate acquaintance with the nature of the mineral ground, and help as a guide to future explorers.

Topographical Character of the Location.*

Tilt Cove, which is the harbour of the Union Mine, is situated on the north side of the great Bay of Notre Dame, about 7 miles from Cape St. John. As a natural harbour it is contracted, being only about 8 chains wide and scarcely double that measurement in length from the south-east outer point to the head. It is moreover exposed to southerly winds, but the holding ground is good, and every precaution has been taken by the enterprising proprietors of the mine to compensate for the deficiencies of Nature, by an ample supply of mooring chains, bolts driven into the rocks on either side, and buoys, together with the erection of an admirable jetty and wharf which in great measure, when completed, will act the part of a breakwater, to ensure the safety and security of vessels visiting the place; and it is worthy of remark that up to the present time, notwithstanding that the appliances have not as yet been by any means perfected, not a single accident has occurred to any of the vessels that have discharged and taken in cargo, although some have left the port at the most stormy season of the year, and as late as towards the close of December. Immediately in rear of the cove lies a sheet of fresh water called Winser Lake, at an elevation of 8·5 feet over high-water sea-level, and connected with the latter by a small stream a little over 2 chains in length. The extreme length of the lake from end to end is about 36 chains, and its breadth at the widest part about

* All the bearings herein given are taken from the true meridian.

16 chains. The lower extreme of the lake is narrow and very shallow, contracting to a width of about 2½ chains at two projecting points where a bridge has been constructed. The upper part expands immediately above the bridge into a rudely oval-shaped basin, measuring about 28 chains in length, with an average breadth of about 15 chains, giving a surface area of about 420 square chains. The greater part of the upper basis is tolerably deep, ranging from 3 to 8 fathoms. The bearing of the valley of the lake, and Tilt Cove which is a continuation of it, is N. 42° W., S. 42° E. This valley is surrounded on all sides by a set of lofty hills, which at Tilt Cove and the lower part of the lake rise in nearly vertical precipices directly from the water's edge to the height (at one of the most elevated parts) of 496 feet; while the upper basin where the hills recede a little, assuming the form of an amphitheatre, and are slightly depressed on either side of the lake, gives a narrow margin of flat land offering facilities for the erection of dwellings and a limited extent of garden cultivation. At the distance of about 14 chains to the westward of Winser Lake there is another sheet of water called Castle Rock Pond, occupying an elevated trough among the hills, the surface level of which is 257 feet above the level of the sea. The length of this pond from east to west is about 19 chains, its greatest breadth, which is at the lower end, is 12 chains, and its average breadth about 8 chains,—the computed area being about 152 square chains. Its waters are discharged into Winser Lake through a gorge in the hills from its south-east angle, falling into the latter in the bay about the centre part of the upper basin on the western side. The depth of this pond was not ascertained, but it appears to be considerable, and its supply will doubtless be found of great importance to the mine when machinery comes to be introduced for the purpose of pumping, crushing, &c., &c. If necessary, a further supply of water might be added to Castle Rock Pond by turning the course of a brook which falls from another small lake at a higher level, and which now discharges its waters at the north-west angle of Winser Lake. On the eastern side of Winser Lake the principal tributary proceeds from the drainage of a marsh which extends along the depression on that side, to the ridge which divides the waters of Winser Lake from those of Beaver Cove Pond. From the eastern side of Winser

Lake a path leads along the depression a little eastward of north-east about 70 chains in a straight line to Beaver Cove Pond, crossing the watershed at about half a mile, passing on the south side of a small round pond, with an area of from 13 to 14 square chains some 8 chains farther on, the water from which flows into Beaver Cove Pond. In shape Beaver Cove Pond rudely resembles the capital letter B, the straight side facing the south-west. In length the lake is 34 chains from north-west to south-east; while across at right angles to that bearing, it measures about 22 chains into each of the bays, and a little less than 12 chains to the long projecting point near the centre part on the north-east side. The area is about 680 square chains. Beaver Cove Pond lies at an elevation of 268 feet over high-water mark, discharging its waters at the extreme southern angle, which falls in a succession of cascades and rapids, in a distance of about 11 chains, into the sea at Beaver Cove. The principal tributary of Beaver Cove Pond falls from a set of small ponds and tarns among the mountains to the northward, into the North Bay at its head.

The character of all this part of the country is mountainous, broken, rugged, and precipitous, affording much and varied picturesque scenery, as may be somewhat understood by reference to a well-executed set of photographic views of the location taken by Mr. Dicks, of St. John's. The hills are in great part either quite bare or covered only by a small stunted growth of evergreens and bushes; and with the exception of a narrow fringe of flat land which surrounds the upper basin of Winser Lake, and a few isolated spots here and there at other parts, there can scarcely be said to be any land fit for cultivation, and it is too precipitous generally for pasturage for any domestic animals but goats. Notwithstanding this generally mountainous character, the highest summits reach to no great altitude in this part of the peninsula. The highest point measured on this location only attains an altitude of 516 feet, that being the summit of the hill directly in rear of the mine, which the proprietors were pleased to distinguish as Murray's Hill or Look-out, it being one of the principal points selected, from its conspicuous position, for the triangulation of the surrounding region. The cliffs which rise in vertical or overhanging precipices on the north-east side of the lake reach at one part, as already stated, to 496 feet. The crag called Castle Rock,

which is the highest part of the depression between Winser Lake and Castle Rock Pond, is only 300 feet, while the small pond on the height of land on the path to Beaver Cove is 420 feet; and the highest summits around probably do not much exceed in any case 600 or 650 feet.

Description of the Mine.

It would be difficult to imagine a place to be more conveniently situated in all repects for the commencement of mining operations than this at Tilt Cove. The lofty vertical cliffs which rise on either side give unmistakable evidence of the presence of mineral wherever it exists, which, were the ground of a more rounded or gentle character, would necessarily be more or less concealed, and possibly might only be discovered by some accidental cutting, or by a system of costeening along the surface. All the work done hitherto, moreover, with the exception of two or three parts of small extent, which were sunk as a trial of the constancy of the ore, has been carried on in drifts at a higher elevation than Winser Lake, thereby avoiding all necessity for pumping engines, or danger from inundation; while the position of the place, by its proximity to the sea, for embarking the ore, is in the highest degree advantageous. The mineralised appearance of the cliffs, especially on either side of the lower end of Winser Lake basin, first attracted the attention of Mr. Smith McKay, in 1857, who was then engaged in exploring the coast; but it was not until the latter part of 1864 that any active operations were commenced to develop the mine. Since that time, up to the end of September last, about 6500 tons of copper ore have been extracted, giving an average yield of about 12 per cent. of the metal. The excavations made to produce this ore have hitherto been confined altogether to the south-west side of Winser Lake, entering the cliffs near the point where the lake contracts at the lower end of the basin; but as the indications in the high cliffs on the north-east side are precisely similar to those opposite, there is every reason to infer that the conditions generally are alike, and a large supply of ore may reasonably be expected. The rock with which the ore is immediately associated, appears to be a chloritic slate, very ferruginous, with seams of serpentine, and having huge intercalated masses of a hard, compact, greenish-grey crystalline rock, which is slightly calcareous, and weathers on the surface of a pale yellowish colour,

and which is distinguished on the plan as calcareous diorite.* The general width of this ore-bearing part where the mine is opened, is rather over 4 chains, or 264 feet; and it is underlaid on the south-east by a bed about 6 or 7 feet thick, of a soft steatitic character, greenish or dark grey on fracture, and occasionally streaked with red, weathering on the exposed surface of a bright brown, which colour descends into the stone from ⅛ to ¼ of an inch. This bed contains masses of serpentine and soapstone, magnetic iron being disseminated through it in grains and crystals. In front, and overlying the mineralised bands, is a mass of hard grey diorite or trap, probably intrusive, containing epidote in strings and patches, and usually more or less characterised by the presence of bitter spar in minute crystals. This rock is succeeded on the north-west by the great body of serpentine of the Castle Rock depression.

The mine is opened upon a set of levels driven into the cliff where the mineralised rock exposes itself, generally following the course of the bedding. Of these levels there are four,—the adit, the upper, Murray's, and the adit winze. The adit level is driven at an elevation of 21·5 feet, the upper level at 65·5 feet, and Murray's level at about 135 feet above the level of the sea; and there is also a small opening where a trial was made at 190 feet over high-water mark. A winze has also been sunk 42 feet from the adit level, from which a level has been driven a short distance at 36 feet, or 14·5 feet below high-water mark.

The following tabular account of the excavations made was kindly furnished by Mr. John Moyle, the captain of the mine, with the permission of the proprietors.

	Drivage.	Winzes sunk.	Stopes.	Cross-cut.	Total.	Remarks.
	fath.	fath.	fath.	fath.	fath.	
Upper Level	50	13½	280	30	373½	
Do. on No. 2 Lode	24	..	12	..	36	
Do. on No. 3 Lode	25	7	71	5	108	
Adit Level	62	13	180	24	279	
Adit Winze Level	26	..	27	..	53	
Bluff Crosscut	..	..	..	12	12	
Bluff Shaft	..	14	..	..	14	
Pond Shaft	..	5½	..	..	5½	
Trial Drift	5	..	..	..	5	
Murray's Level	..	..	..	..	..	Just opened; no particulars.
					886	cubic fathoms.

* Or rather, probably, a volcanic ash.

From this total of 886 fathoms of excavation, 6500 tons of ore, yielding about 12 per cent. of copper, have been extracted, giving an average of about 7½ tons to the cubic fathom. The ore, although running generally subordinate to the stratification, does not appear to extend for any great distance in regular and continuous sheets, but rather to occur in bunches of greater and smaller dimensions, or to permeate the softer and more slaty rocks in greater or less degree. The ore-bearing parts have been found usually to come abruptly against a wall of hard diorite on one side or the other; and the latter in some instances penetrates the former, in the form of what the miners term "horses." The strata are all much corrugated, and many small dislocations were observed; and there seems to be evidence to show that the masses of ore are greatest towards the axis of the corrugations, while strings and leads often run in the course of the small faults or cracks. After driving on the upper level for about 200 feet, more or less, upon ore, in a nearly due south course, the ground was found to become barren, which it continued to be through between 70 and 80 feet more in the same course, and in consequence the work in that direction was abandoned. A cross course was then driven from the part where the ore disappeared, nearly due west, which, after passing through barren ground for about 86 feet, came upon a band of solid yellow copper ore, which proved to be 4 feet thick. This 4-feet band was styled lode No. 2. Driving across this 4-feet band, and on in the same direction, a mass of rock or "horse" was passed through, some 10 feet thick, beyond which an enormous bunch of yellow copper was struck, measuring in the direction of the drift about 22½ feet, and 36 feet at a higher level. This bunch is distinguished as lode No. 3. The great bunch of No. 3 lode seems to rest upon a hard compact dolomite or diorite, in nearly a horizontal attitude; but in the northern drivage, the course of which is nearly true north, it dips at an angle of from 45° to 50° about N.N.E. These dips, however, are probably the effect of an overturn, as it is nearly exactly contrary to the general inclination of the bedding. It is not improbable that this great mass occupies the same plane in the stratification as the ore which shows itself on the surface in front of the houses within a little distance of the lake shore, and in the pond shaft. (See plan.*) No. 2 lode has been followed from the

* The plans are deposited at the Crown Lands Office, St. John's.

part where it was first intersected in a course very little removed from true south, in a very straight line, for 76 feet, carrying ore all the way, the drivage being bounded on the west side by a vertical wall of hard rock. At the end of that distance a small displacement is met with (termed a "Fluccan Head" by the miners), which, for a thickness of about 6 feet, is filled with a soft unctuous clay. Beyond the Fluccan Head the course continues on rich ore as previously, having the same wall on the western side, for 54 feet; and it then takes a turn S. 23° E., still carrying ore, and with the wall rock on the west side for 23 feet more, coming at the end of that distance abruptly against a vein of white quartz, probably produced by another displacement. Murray's level is driven into the side of the hill at about 80 feet to the westward of the course of the southern (or, as it is called at the place, "the south-western") drivage; first taking a course in a similar southerly direction for 25 feet, from which point two further drivages have been made,—one S. 7° W., 25 feet, and the other S. 67° E., also about 25 feet. Ore was met with to considerable extent in all these drivages, and the latter one was strongly marked by the presence of green carbonate of copper; but the shattered condition of the rocks and the presence of quartz veins appear at this place, as in the southern drift on No. 2 lode, to indicate a dislocation. What the value of this fault may be is still very uncertain. While on the spot, suspecting the possibility of an occurrence of the kind, I endeavoured to trace the steatitic band at the base of the mineral-bearing rocks, and did so without difficulty as far as the lower trial drift, which is situated in the forks of two small rills falling from the mountain (see plan) a distance from the outcrop on the lake shore, in a straight line, of from 8 to 9 chains; but beyond this the ground was hidden under a mass of fallen débris and thick impenetrable bushes; and, in consequence, I suggested that the surface should be "*costeened*" at right angles to the general run of the bedding, in order to prove whether the strata were continuous or broken. The result, if the operation was put into effect, has not been communicated; but there is certainly some reason to suspect that the dislocation here may prove to be of considerable importance, as it may be found, on further investigation, that the strata exposed at the extreme lower end of the lake on the western side is a repetition of that where the mine is opened; in which case there would be a

downthrow to the south-west of several hundred feet. Although this circumstance has not yet been proved to be a fact, there are several cogent reasons to assume the possibility of such an occurrence, particularly as a band of steatitic character associated with dolomite was observed on the western side of the tongue of land at the lower end of Winser Lake and traced up the side oı the hill west from it, which is succeeded by ferruginous strata of very similar character to that in which the ore has been found to be deposited. It was further remarked that while calc-spar and bitter spar were generally diffused in small veins or patches through the ore-bearing part of the deposit north of the Fluccan Head, quartz was nearly or altogether absent; whereas, on the south side of that disturbance, small quartz veins become apparent both below and on the surface, which also is the case where the fault may be supposed to run out at the foot of the lake. The course of this dislocation, should these suggestions be borne out, would be very little removed from due east and west, and would run in the direction of Castle Rock Pond. The adit and the adit winze levels are excavated roughly parallel with and almost directly underneath the course of the upper level, north of the position of the latter, where the ground became barren; both well charged with ore, and passing through numerous rich bunches of yellow copper. The winzes, also connecting the three levels, are sunk on ore, some of which is rich yellow sulphuret all the way. This connected mass has been termed lode No. 1. Galleries have been driven westward also from the adit level, and ore met with; but whether the latter is connected with either No. 1 or No. 2 lode does not yet appear; but it seems evident that the bunches of lode No. 1 occupy an inferior plane of the stratification to those of lode No. 2.

The exposed surfaces of the ore-bearing parts of the formation are characterised by the presence of a great abundance of iron pyrites or mundic, the decomposition of which has in a great measure given origin to the ferruginous appearance they invariably exhibit; but besides the sulphuret there is also a vast amount of magnetic iron ore, disseminated not only in small specks and crystals but in huge masses, which in some instances may prove of economic importance. One of these masses occurs in the mine bluff immediately in rear of the position of the levels where the

copper was extracted: and another, which is described as a bed or band some 3 or 4 feet thick interstratified with the serpentine, has been uncovered, as I am informed, since I left the place, near the north-east angle of Winser Lake. The same ore was observed at the south-east angle of Castle Rock Pond; and on the north shore of that pond the local attraction of the magnet was found, when making the survey, to be so powerful at some parts as to occasion the divergence from the true meridian to vary from 4° to 60° in the space of about six paces. Jaspery iron ore was observed to run up the face of the cliff towards the powder magazine, on the west side of the cove; and specular iron occurs on the east side among the high cliffs. Blende, or the sulphuret of zinc, also, is frequently met with the copper ore.

Among other material which may prove of economic importance upon this location is the serpentine, which when properly selected will doubtless be found to produce a very beautiful marble. A section of this rock, apparently of a very handsome quality, is partially exhibited in the little stream which falls into Winser Lake near its north-eastern angle, and likewise on the cutting on the road leading to the graveyard. There appears also to be a large amount of a steatitic mineral with the more shaly parts of the serpentine in the depressions on either side of Winser Lake; and at one part, where a drain has been dug on the east side, a layer of this description is exposed, which appears to be of a quality fit for use as a tailor's crayon. It is usually of a reddish hue, probably being stained by iron, but it gives a clear white mark upon dark-coloured cloth, which is easily erased. Asbestos was frequently observed among the serpentines, in veins varying in thickness from one-eighth of an inch to upwards of an inch.

Following the serpentine, from Winser Lake in the direction of Beaver Cove Pond, the depression between the more elevated hills was found to contract towards the watershed, and at the small pond on the eastern side of it the cliffs rise pretty precipitously nearly from its margin; those on the west side consisting of the harder serpentine rocks, while those on the east are diorite. On the western side of the same pond there is an exposure of ferruginous and chloritic slate, which probably represents the mineralised part of the formation; but neither this nor the overlying serpentine

could be traced to the northward towards Beaver Cove Pond, that part being occupied by a mass of diorite. On ascending the valley of the brook which falls into the north-western bay of that pond, however, the serpentine was again met with in considerable volume, forming cliffs of 50 or 60 feet in height, where it showed a dip of N. 12° W. < 45°. There would thus appear to be a considerable dislocation affecting the run of the strata here, the upthrow on the north-east side of the fault being probably not less than 1000 feet. This fault seems to correspond with a dislocation previously observed at the cavern on the east side of Tilt Cove, and at the outer point called the "Scrape," or the eastern head of Wild Bight, where a large vein of white quartz marks its position, in which case its run would be about N. 20° E., S. 20° W.

The depression on the western or north-western side of Winser Lake runs on the serpentines to Castle Rock Pond, where they are displayed on the eastern and northern shores. The bluff on the southern shore at the outlet is a hard compact diorite, with grains and masses of magnetic iron; and the bluff next west from it is ferruginous and chloritic slate, thickly charged with minute crystals of magnetic iron and with decomposing iron pyrites, resembling the ore-bearing part of the formation.

Topographical Character of the Country between Castle Rock Pond and Snook's Arm Pond.

The depression between the hills, observed at Winser Lake, continues to the westward of Castle Rock Pond; and a path leads along it in a course a little to the south of west, with a distance of between 30 and 40 chains to Long Pond. The shape of this pond is very irregular, its general bearing stretching nearly due west for upwards of a mile and a half, but expanding into deep bays which fall back on both the north and south sides; the peninsulas of which, one from the eastern and the other from the western ends, nearly meet towards the centre, dividing it nearly into two parts. (See plan *.) For the convenience of description, the whole sheet may therefore be divided into four arms, viz., the eastern, the western, the northern, and the southern arms. The eastern arm measures in length about 34 chains, with an average width of about

* At Crown Lands Office, St. John's.

12 chains, giving an area of surface of about 408 square chains; the western arm is about 76 chains long, average width 11 chains, surface about 836 square chains; the southern arm, which includes the smaller bays on that side, and the expansion just above the outlet, contains an area of about 348 square chains; and the northern arm, which is entered by a channel bearing up northeasterly for 24 chains, with a breadth of 8 chains, terminating in an oval-shaped basin measuring 40 chains from west to east, with an average breadth of about 16 chains, gives an area of nearly 832 square chains. The total area thus computed would be 2424 square chains, or rather more than one-third of a square mile. A small pond, having an area of about 136 square chains, which is divided from the eastern end of the northern basin by a rocky ridge of only 3 chains in width, discharges its waters from its south-eastern angle, which fall in a succession of diminutive tarns, connected by a small rapid brook, into the extreme head of the eastern arm. A rocky ridge, about 14 chains wide, divides the western arm from another lake which was not surveyed, but was estimated to contain a surface area of about 1560 square chains, the waters from which are discharged into the western end of the northern arm. A small pond called Beaver House Pond, with an area of about 168 square chains, also discharges its waters through a brook, only 2 chains long, into the southern arm on the east side. The height of the surface of Long Pond was calculated by aneroid to be 268 feet above the level of the sea, and its waters flow from the south extreme of the southern arm, by Fannon's Brook, into Wild Bight, at its head, in a distance of little over half a mile in a straight line.

Two lines, one being drawn nearly due west from the western end of Long Pond for about a mile and a half, and the other due north from the head of Snook's Arm, about 1 mile 50 chains, will intersect at the eastern extreme of another important sheet of water called Red Cliff Pond. Between the latter and the large pond north of the western arm of Long Pond there is said to be water communication, broken only by an interval on the dividing ridge of about half a mile; but as this part was not surveyed, no particulars can be given with certainty. These sheets o water, trending as they do in a general direction and at a tolerably uniform level, are important, inasmuch as to a certain extent they

seem to indicate the run of the rocks throughout the region, besides affording facilities for exploring and examining parts which otherwise might be inaccessible. From the eastern extreme the main body of Red Cliff Pond bears downwards towards the outlet S. 68° W., 1 mile and 32 chains, with an average breadth of 23 chains; while a deep round bay falls back to the southward from the eastern end, measuring roughly about 40 by 30 chains. The total area of the lake would thus be about 2576 square chains, the height over sea level being 285 feet, by aneroid. The outlet leaves the lake at its extreme western end, turning in a south-easterly direction, at nearly a right angle with the lay of the lake, and at the end of about 15 chains falls into another sheet of water called Snook's Arm Pond. The bearing from the inlet at the head to the lower end of Snook's Arm Pond is S. 40° E., distance 57 chains (that bearing being along the main body of the lake), the eastern shore of which is gently curved, forming small bays and coves; while the western side is deeply indented by three bays, divided by long projecting promontories and small rocky islands. The surface area of this pond is about 1426 square chains, and its height above the sea, by aneroid, 276 feet. The outlet leaves the lake at its extreme south-east angle, and flowing southerly with great velocity in a succession of cascades and rapids, with one wide open pool of still water about midway, for about 53 chains, when it falls into the sea at the north-western angle of Snook's Arm.

The region surrounding these lakes is everywhere very rugged and broken; the hills rising sharply and precipitously over the ponds, tarns, and marshes, which everywhere occupy the low grounds. The hills, which rarely attain an altitude of over 600 feet, are generally more or less clothed with a scanty vegetation of dwarfish timber and berry bushes. On the south side of the western arm of Long Pond a remarkable hill rises abruptly from the water's edge to the height of 179 feet over the lake level, or 447 feet above the level of the sea, which from its shape was called the "Sugar Loaf," and which proved from its conspicuous position to be a valuable feature for the continuance of the triangulation of the country. Another important auxiliary to the triangulation was found in the bare and rocky summits of the Red Cliff Hills which rise over the northern shores of the pond of the

same name to the height of 318 feet, or 603 feet over high-water mark. This range of hills lies immediately on the south side of the watershed, dividing the waters which flow to the north into the sea east of White Bay, from those which fall into Notre Dame Bay to the south; the country to the north, consisting as far as the eye could reach from the highest elevation, of a series of rocky ridges, barrens, and extensive marshes and tarns; patches of stunted woods occupy the slopes and some of the lower depressions.

Distribution of the Rocks.

Although at all times a very difficult matter to identify the precise equivalent of geological formations in regions remotely apart from each other, and most especially when the strata are altogether unmarked by the presence of organic remains, as is the case throughout the country under description, there nevertheless seems to be no reason in the meantime to doubt that, for the greater part at least, the rocks on the south side of this peninsula are of the age of the Quebec group; and, further, that the mineralogical and metalliferous character of a large portion of the strata seems to indicate the horizon of the Lauzon division of that group.*

The following will in some degree represent a section drawn across the measures, generally at nearly right angles to the run of the stratification from Tilt Cove, in a course N. 34° W., passing nearly over the mine, and on the south-west side of Winser Lake, in a distance of 100¼ chains.

Ascending Order.	Measurement on Section.	Thickness of Strata.
a. Corrugated slates, with bands of red jasper	466†	620†
b. Corrugated slates, with bands of red jasper, variegated	594	920
c. Corrugated slates, with a strong band of red jasper at the top	396	
d. Diorites, with dark green slates, both weathering a rusty brown, cut obliquely by numerous small white quartz veins, which incline about north, and intersected by parallel joints, underlying westerly .	565	495
e. Black calcareous slate, with thin veins of calc-spar, frequently stained with green carbonate of copper .	600	600

* See Appendix to my Report, 1864-65.

	Measurement on Section.	Thickness of Strata.
f. Dark green slates and quartzite, with much jasper, both red and brown, and narrow bands of jaspery iron ore. At the top a band of dolomite which contains strings and patches of serpentine, small veins of calc-spar, some small quartz veins, and specks of copper, weathers rusty brown	900	800
N.B.—The band at the top of *f* may possibly be identical with the band at the base of *h*, in which case *g* is repeated.		
g. Dolomite, for the most part in very hard strong beds, of from 1 to 2 feet thick, of a greenish-grey colour, weathering whitish, interstratified with magnesian and green chloritic slates; mineralised cliffs very ferruginous	690	670
h. Green chloritic slates with large lenticular masses of calcareous diorite, with serpentine, great masses of yellow sulphuret of copper, and magnetic iron. Blende also is frequently disseminated. At the base is a band, of about 6 or 7 feet thick, of a magnesian rock, which in parts has the character of soapstone, and contains magnetic iron disseminated in small specks and crystals	350	350
i. Diorite spotted with transparent white crystals of bitter spar, and contains epidote largely in seams and small bunches	350	350
k. Serpentine, a large portion of which is very soft and shaly, contains asbestos in thin seams. Magnetic iron disseminated in crystals, and appears in one part to contain a strong band of the same	1065	1020
l. Cream-coloured steatitic slates, with red jaspers in bands and pebbles, sometimes giving the character of a conglomerate, and shows numerous green specks of the oxide of chromium	315	335
m. Greenish slate with quartzite	525	615
Total—about	6816 ?	6775 ?

In this section it will be observed that a steatitic band is represented to come in, as at the summit of the division *f*, which is succeeded by mineralised ferruginous slates in division *g*; and that a similar sequence occurs within the division *h*; but whether this is the effect of a dislocation, causing the strata to be repeated, or that they are two distinct sets of bedding, has not been satisfactorily proved. Should there be a repetition, the thickness of strata would be considerably smaller.

The serpentines of division k of the section have already been shown to run in the depression on either side of Winser Lake, and to occupy the ground between the latter and Castle Rock Pond. From Castle Rock Pond the course of the same strata continues westerly, still keeping in a depression between the hill ranges on either side, and bearing for the peninsula of Long Pond, which separates the eastern from the northern arms. The same strata are further exposed on the small islands of the western arm, on the peninsula between it and the southern arm, and on both sides of the long inlet at the head of the same arm, where they run into the country westerly, following the course of a small brook. Continuing a westerly run, these rocks are again recognised at the north-eastern extreme of Red Cliff Pond, whence they strike along the main body of the lake, the lower members of the division skirting the southern shore, to the outlet into Snook's Arm Pond, where they are abruptly cut off by a fault, apparently throwing the measures down on the south-west side. The rock on the west side of the fault is a diorite, curiously arranged in a set of parallel ridges, running nearly at right angles to the strike of the serpentines, with a sharp escarpment facing easterly and inclining westerly at an angle of from 25° to 30°. This diorite is intersected by numerous veins of quartz, which usually contain chlorite. The largest vein seen was about 3 feet thick. Epidote also is distributed through the diorite. Overlying the serpentine of division k, a cream-coloured slate, somewhat unctuous to the touch, containing red jasper in irregular bands and in rounded pebbles, together with bright green spots and patches, supposed to be an oxide of chromium, occurs, running on the north side of it with great regularity from Red Cliff Pond to Beaver Cove Pond; while at or near the base of the same division (k) there usually appeared to be more or less of a thickness of very ferruginous slate, containing iron pyrites in large quantities, and magnetic iron, with irregular intercalations of dolomite, which were supposed to represent the mineral-bearing part of the deposit (the equivalent of i or h). At and round the base of the Sugar Loaf Hill, on Long Pond, these ferruginous rocks are displayed to considerable extent, holding yellow copper, iron pyrites, and magnetic iron, and they are underlaid by a narrow band of dolomite, which is sometimes of a breccious character, containing

angular and irregular masses of chert. At some parts the same band becomes of a bright red colour, but always weathers of a rusty brown, the weathered discoloration sinking into the rock at some parts to the depth of a quarter of an inch or more. On the south side of the main body of Red Cliff Pond, likewise, similar mineral characteristics obtain, the rocks all highly impregnated with the ores of iron, and with indications of the presence of copper and a dark brown mineral, probably chromic iron.

It may be observed by what has been said that although the rocks are in many parts affected by violent disturbances, and are everywhere more or less corrugated, contorted, and dislocated, they still maintain a moderately straight course, within the limits of the survey, and that the tendency is to run in nearly a parallel line to the coast. This fact seems still further to be borne out by the exposures in the cliffs of the coast itself, where the strike of the rocks is nearly or quite coincident with the general trend of the coast line, as is well exemplified by a great band of interstratified red jasper, which can be traced from the point called "the Scrape," on the western side of Tilt Cove, along the shore of Wild Bight, striking into the country near the head of that bight, crossing Fannon's Brook about half-way between the outlet of Long Pond and the sea, and finally reappearing on the eastern side of Snook's Arm towards the head. On the north-eastern side of Snook's Arm Pond, at a projecting point, the rock is purplish and green talcoid slate, dividing into very thin laminæ on the plane of the bedding, with thin calcareous seams running in the cracks, the bedding striking N. 55° E., S. 55° W., in a nearly vertical attitude, or dipping at a very high angle to the northward, and intersected by a set of parallel joints running exactly at right angles to the strike underlying westerly at from 35° to 40°. In the bay, north of this point, the rock is of a pale greenish-grey colour on fracture, very hard and compact, weather-black or dark green, showing a breccious or nodular structure on the polished surface, and intersected by thin irregular seams and patches of red jasper. In the bay to the south of the Slate Point there are alternations of hard greenish slates and quartzites, the latter in beds from 1 to 2 feet thick, intersected by small quartz veins, and containing epidote. These rocks may be presumed to

be the representatives or equivalents of the divisions *f* and *g* of the section. The fault which was observed to cut off the serpentine at the lower end of Red Cliff Pond appears to run through Snook's Arm Pond in a course about S. 40° E., passing a little west from the slate point, and bearing for the head of Snook's Arm, bringing the strata down on the west side apparently from 1500 to 2000 feet, and repeating the slates of the point and the overlying strata on the shores of the bay at the southern end of the lake.

The strong band of red jasper at the summit of division *c* of the section has been shown to run out on the northern side of Snook's Arm towards the head. It is there succeeded to the eastward by a set of variegated green, red, and blackish slates, which in a vertical attitude, or nearly so, strike into the land obliquely, pointing towards the head of Wild Bight. The thickness of this mass of strata was not ascertained, but a portion of the summit is represented in the section by divisions *a*, *b*, *c*.

Following the coast to the westward, the variegated slates were observed to run out at several places between Snook's Arm and Bett's Cove, dipping in various directions, and sometimes much contorted. On the eastern side of the bay, next west from Snook's Arm (which is known locally as Wild Bight, being the second of the same name on this coast), the dip is north-easterly; but on the west side it is a little west of north, which circumstance leads to the inference that the bight or bay rests on the axis of an anticlinal, while the tongue of land between the bight and Snook's Arm is the seat of a trough or synclinal. In like manner these rocks probably make several smaller undulations in their western course, and bending round finally with a sharp sweep on the eastern side of Bett's Cove, run into the sea, and are no more exposed eastward of Nipper's Harbour. In Chance Cove, which is immediately to the west of Bett's Cove, a mass of serpentine comes out upon the coast, showing a dip to the north; and farther west, on the western side of the Lowlands' Brook, a similar mass was observed striking into the country in a vertical attitude directly north. Farther west still, serpentine rocks were found to exist at the entrance to Burton's Pond, and to run along the south-eastern side of that pond, where they appear to be interstratified with quartzite, diorite, and nacreous slate with

steatitic bands. Near each of the places specified, where the serpentine occurs, indications of the presence of copper present themselves on the cliffs, which are frequently, and to a great extent, stained by green carbonate; and at the entrance of Burton's Pond there is a considerable display of copper pyrites and sulphuret of iron, upon which an opening has recently been made, and some good specimens of copper ore extracted. At this place the ore is evidently running in a dislocation, the direction of which, however, seems to be nearly or quite parallel to the strike of the stratification, namely, N. 30° E., and it underlies to the westward at an angle of about 70°. The lode at the entrance of the excavation is from 7 to 10 feet wide, and consists of a soft, blackish, shaly, and unctuous slate, or "killas," having strings of calc-spar and some white quartz distributed through it irregularly, with the sulphurets of copper and iron. A wall of a hard fine-grained rock, of a dark greyish colour on fracture, but weathering a rusty brown, supports the lode on the east side, which, jutting out into the cove and forming a small reef, displays yellow copper ore on its upper surface to the water's edge. On the west side of the lode the rock is of a dark green colour, very hard and compact, and slightly calcareous, with thin irregular seams of serpentine.

Westward from Burton's Cove and Pond the rocks of the coast are much disturbed by intrusions of syenite, one part of which, at the entrance of Nipper's Harbour on the west side, and immediately north of that part called "the Cove," has a width of from 7 to 10 chains, the dyke bearing a general course about S. 50° W. The continuation of this intrusive mass is seen also on the eastern side of Nipper's Harbour, with a width of from 3 to 4 chains, cutting through the strata in a course about N. 38° E. The prevailing colour of the intrusive masses is red, and they weather very red, making a conspicuous contrast with the dark-coloured rocks on either side. The constituents of the rock are chiefly red feldspar and quartz, the former preponderating, the latter in small translucent grains, with a small proportion of a greenish mineral, probably hornblende. On the north side of the syenite at Nipper's Harbour the rock is a dark grey quartzite in heavy beds, interstratified with silicious slates of the same colour, with epidote generally disseminated, all weathering in shades of brown, drab, or

black. These rocks, the stratification of which is very distinct at some parts, appear to butt against the syenite at nearly right angles, presenting a westerly dip at a high angle. The rock of the southern point of Nipper's Harbour, as exhibited on the south side of the cove, is a soft greenish slate with calcareous veins, which probably may belong to the serpentine division of the group.

At the head of Nipper's Harbour, by the entrance into the Salt Water Pond, the rock is of slaty structure, of a greenish or greyish colour on fracture, weathering a dark rusty brown, very fine grained and silicious. The low cliffs on each side of the entrance to Salt Water Pond are considerably stained by green carbonate of copper; and yellow copper and iron pyrites are pretty thickly disseminated in the rock.

The main mass of intrusive syenite already mentioned can be traced in its easterly course from Nipper's Harbour, running a little to the northward of Pitman's Bight, on to the north-western side of Burton's Pond, with tributary dykes of similar character, but of more moderate width, radiating from it on the south side towards the sea, cutting through the stratified deposits, sometimes at right angles and more frequently obliquely to the strike. Bearing generally in a north-easterly direction, the intrusive syenite appears to make towards the Red Cliff Hills, on the northern side of the Red Cliff Pond. The Red Cliff Hills are of a pale pinkish feldspathic rock, showing no evidence of stratification, and are separated from the slates, which occupy the ground between them and the lake, by a great vein of white quartz, sometimes 6 or 7 feet thick, from which many others reticulate; and they are bounded on the north side by a set of schists, mostly of a yellowish or drab colour, which extend through the country across the watershed. Still farther on to the north-eastward, on the path leading from Shoe Cove to La Scie, about half-way between the two places, pale red feldspar rock comes up, in dome-shaped masses, protruding through dark blue clay slates over a breadth of about half a mile, which, running on north-easterly, would probably terminate somewhere near the Middle Bill of Cape St. John.

Of the country to the eastward of Beaver Cove Pond little can as yet be said, as hitherto the exploration of that part has been limited to an excursion across the peninsula from Shoe Cove to La

Scie. From the brook at the head of Shoe Cove the path leading to La Scie follows a general course about N.N.W., and the distance in a straight line is a little over 3 miles to the head of La Scie Harbour. The portage crosses over an elevated broken country, the maximum height of which was found by aneroid to be about 500 feet above the sea, and the average probably about 400 feet, the hills partially clad with the usual evergreen trees, and the lower parts and hollows interspersed with numerous ponds and marshes. Between the high land and the head of La Scie Harbour there is a considerable area or flat land, extending in a north-easterly and south-westerly direction, at the foot of the hill ranges, which is chiefly marsh, but with spots of considerable size of good soil, quite capable of being cultivated to advantage and producing spontaneously in many places an abundance of excellent grass.

The rocks exhibited in the coast cliffs to the north-eastward of Beaver Cove are probably lower in stratigraphical position than the lowest of the section *a*, *b*, *c*; but they are all so much disturbed, and the difficulty of approach to them is so great, that it was found to be impossible to effect more than a casual examination while passing along in a boat. A large amount of the strata appeared to consist of quartzite or diorite, probably both, and small bands of red jasper are numerous. At Capelin Cove, which is about half-way to the brook at Shoe Cove, a narrow valley cuts into the country from the sea-shore, bearing about north-west, where there was supposed to be a fault running in the same direction. On the north side of this valley some parts of the rock are of a pale reddish colour, assuming a syenitic aspect, and this is confusedly mixed up with slates and hard beds supposed to be quartzite; but it would require much further investigation to determine what the value of the fault may be, or to arrive at a satisfactory conclusion as to the stratigraphical detail; nevertheless, there is reason to assume the probability of there being an upthrow of considerable extent on the north-east side, shifting the upper rocks of the section to the northward, which otherwise might have been expected to make their appearance somewhere not very far from Capelin Cove. At the mouth of the brook in Shoe Cove the rock is a green chloritic slate, with some soft shaly strata, which is overlaid on the shores of the pond just above the outlet by strong bands of diorite cut up by

numerous veins of white quartz of various thicknesses, the largest observed being about 8 feet across. The general dip of these rocks is northerly. Rising the hill, about half a mile north from the sea-coast, a set of pale grey, slightly calcareous and finely micaceous slates were crossed, dipping northerly about 45° towards the hill; and these are succeeded by some soft shaly strata, amongst which some masses of serpentine were observed with cream or drab-coloured slates, holding green specks and patches of chrome, and occasionally a few red jaspers. These were overlaid by dark bluish clay slates, which cap the ridge at the highest elevation. This accumulation of strata from the sea to the top of the hill was assumed to be equivalent to the upper part of the section above the base of *f*.

Northward, from the crest of the hill range, the country is more or less occupied over a breadth of about half a mile by syenitic rock, apparently cutting through clay slates, as already stated; but beyond that distance slate of a dark blue colour was the only quality of rock observed till within about a quarter of a mile of La Scie, where the rock surrounding the harbour was found to be gneiss. The colour of this gneiss is for the greater part red or pink, the chief constituent mineral being red or pink feldspar, but there are also portions of a grey colour on fracture which weather brown or blackish. Neither mica nor hornblende is largely disseminated in this rock, and when either or both are present they seem to be arranged in thin parallel seams, corresponding with the layers of different colour and quality.

Resting apparently unconformably to this gneiss, a little to the eastward of La Scie Harbour, a great mass of stratified quartzite,* mostly pure white, with occasional bands of a pinkish colour, and alternating layers in smaller proportion of dark-coloured or blackish chert, is brought in, in the form of a narrow elongated trough, the axis of which lies as nearly as possible due east and west, in a distance a little over a mile, and with a breadth varying from a few chains to upwards of a quarter of a mile; the rocks on the north and on the south sides dipping generally at a moderately high angle towards the centre. At the eastern extremity of this

* From information received on a former occasion, this quartzite was supposed to be white crystalline limestone, but the place was not visited personally until the present season.

trough a small rapid brook cuts a deep and narrow gorge through the quartzite, and displays blackish or dark grey slate on its bed and banks; while another isolated mass, corresponding with the rock of the trough, comes in, forming the nearest high land, in a sort of round patch to the eastward.

What the age of either this gneiss or the overlying quartzite may be, it is impossible in the meantime to state with any degree of certainty, and much more investigation will be required to elucidate the subject. It is obvious, however, that the mineral character of the rocks on the north side of the peninsula, so far as at present known, differs materially from those on the south side; and it has been shown that there is evidence of a great intrusion running nearly parallel with the south coast line between Nipper's Harbour and Cape St. John; but whether this intrusion has been the means of bringing up lower strata on the north side, or whether the strata on that side is contemporaneous or higher in the geological section, in a metamorphosed condition, than that on the south, there is as yet no data on which to found an opinion.

From the above statements it will be perceived that the mineral-bearing portion of the formation in which the Union mine is situated runs in a general direction nearly parallel with the south coast, but coming out upon it near Nipper's Harbour; and that the presence of metallic ores are more or less indicated at many parts in nearly the same relative position to the serpentines as they are at Tilt Cove. As, therefore, your Excellency was pleased to express a desire that I should suggest a plan upon which the grants of mineral lands should be distributed, I beg leave to propose the following, as what I conceive to be the most equitable, and which your Excellency will find illustrated upon the large map for approval or modification.*

Taking Beaver Cove Head, on the east side of Beaver Cove, as a starting-point, the bearing along the coast from there to the Nipper Islands off Nipper's Harbour is S. 60° W. from the true meridian. Taking this line as a base, a line may be drawn astronomically N. 30° W. (or at right angles to the base) for 4 miles or more, as occasion requires, and the whole area blocked off into squares of 1 statute mile each. The coast frontage may then be registered as concessions or ranges, numbering 1, 2, 3, &c., while

* MS. maps at Crown Land Office, St. John's.

the intersected country will be divided into lots numbering 1, 2, 3, &c., inland. A licence of search upon this plan ought to be confined to 1 mile of frontage and 3 or more miles inland, as the case may be, and the square mile selected for grant, finally, should be one of the blocks on the same concession. In cases where broken frontage occurs, special allowance might be made in the grant for deficiency of superficial area, but the licence should apply to the concession indicated only, nevertheless. A right of way to the nearest harbour should be reserved to every lot, and the lines of road determined according to the physical character of the country. Where natural facilities for travel offer by lakes or ponds, the right of navigation in such waters should apply to all locations connected with a common harbour. To provide against probable inaccuracies in the surveys (either of the coast or inland), the headlands, or other prominent or well-marked natural features, as near as possible to the parts where the lot-lines strike the coast on the plan, should be specified, whence the terminal boundary of such and such a lot and concession can be fixed and the divisional lines be drawn, blocking the country off in areas of a square mile, *more* or *less*, each; and all surveys must be made astronomically, as in many cases through the mineral country the local attraction is so great that the magnet is perfectly useless, and can only lead to error.

In laying off mineral lands in other parts of the province, it seems to me to be advisable that a similar system should be adopted to that proposed for the peninsula of Cape St. John, modifying the bearing of the lines of survey to accord, as fairly as possible, with the strike of the mineral-bearing strata, or the run of mineral veins or lodes; as by such means an ample area for any mineral adventure will fall to each grant without risk of undue monopoly falling to the lot of any party in particular.

In conclusion, I have to inform your Excellency that I already possess some data upon which to found further geological information relating to parts of the islands visited in previous years; but as there are many points which require much more extended investigation, before the structure of the country can be sufficiently understood, I have considered it prudent to reserve entering into minute details for the present, in the hope of, within the ensuing season, being enabled to gather much more knowledge of the sub-

ject, and afterwards having all my facts, together with my collection of specimens, referred to Sir William Logan, under whose supervision they will be satisfactorily examined.

I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

His Excellency Anthony Musgrave,
Governor of Newfoundland, &c. &c. &c.,
St. John's.

CHAPTER VIII.

REPORT FOR 1868.—DISTRIBUTION OF THE FORMATIONS IN THE PENINSULA OF AVALON, WITH SECTIONS; AN ACCOUNT OF THE ECONOMIC SUBSTANCES, &c. ALSO A MEASURED SECTION OF THE CARBONIFEROUS ROCKS ON THE WESTERN COAST, BETWEEN THE GREAT AND LITTLE CODROY RIVERS.

May it please your Excellency,—

I beg to submit for your consideration the following condensed Report of the progress made on the geological investigation of this island during the past year, and hope that the same will meet with your Excellency's approval, and that the prosecution of such researches may prove eventually to be conducive to the material prosperity of Newfoundland.

My labours during the past year have been exclusively confined to the regions surrounding Conception, St. Mary's, and Placentia Bays, the object being to ascertain with some degree of certainty the peculiarities of geological structure throughout these parts, which have hitherto, as I have remarked in previous reports, been very imperfectly understood; and I beg once more to reiterate that it can only be by a thorough knowledge of the geographical distribution of the geological formations, and the production of reliable maps and sections, that the mineral importance of the country can be satisfactorily exhibited before the world at large, or in any degree properly appreciated.

Since my return to St. John's, I have been daily busily engaged in the construction of maps of the above-named bays, in connection with certain surveys of my own; which operation has been much facilitated through the kindness of Captain Kerr, R.N., of the Admiralty Coast Survey, who permitted me to take tracings from his original manuscripts. The maps referred to are all laid down to a scale of 1 inch to 1 statute mile, corresponding with others previously submitted, my design being finally, when the country is more perfectly explored and examined, to produce one

general map on a scale of one-fourth the size for the use of the Government; while any smaller scale may be adopted at a future time for publication or circulation.

A large collection of fossils and minerals has been made, which, for the want of a more convenient place, is now deposited at my own premises. These must necessarily be submitted to palæontological and chemical examination previous to entering into particulars respecting them, and I am in hope that such assistance may be obtained early in the ensuing spring through Sir W. E. Logan.

While examining the coast of Placentia Bay, I considered it my duty to make a partial survey of the La Manche mining location; a plan of which, with as much detail as I was able to collect, is now in process of construction on a large scale, and which I hope to have the honour to submit when completed. A collection of some beautiful and interesting minerals was also made from the same location.

From the heights over the La Manche mine, a system of triangles on the most prominent points and conspicuous mountains was commenced, which was finally extended far into the interior; which proved of great service, in fixing the position of my observations when back from the coast, and checking the same by taking frequent observations of the sun and stars to determine the latitude.

I was indebted to Mr. John English, of Branch, in St. Mary's Bay, for a very useful general sketch of the topography of the peninsula between St. Mary's and Placentia Bays, which I have since introduced on my own map and made to fit the scale.

Of the Sequence and Distribution of the Formations.

Although much of the country is still insufficiently explored, and many of the minuter details but imperfectly followed out, the evidences collected during the season seem nevertheless clearly to indicate the greater and more important features of structure presented over the peninsula of Avalon; and to show that throughout that region, and probably for a great distance westward from it on the mainland, there are no rocks of more

recent date than the lowest members of the Silurian system distributed over the surface.

A great intermediate formation is interposed between the Laurentian gneiss (the lowest of all recognised sedimentary deposits) and the Lower Silurian strata, which spreads over by far the greater proportion of the peninsula, and for a long distance beyond; the gneiss of the Laurentian series coming to the surface on the axis of anticlinal folds or brought up by great faults, and in the case now to be considered is flanked or at times surrounded by rocks of a totally different lithological character, which, from many of its characteristics, I have long considered would prove to be the equivalent of the Huronian system of Canada. The region in question in particular, and probably the whole island in general, seems to be ranged in an alternation of great anticlinal and synclinal lines, independent of innumerable minor folds, which preserve throughout a remarkable degree of parallelism pointing generally about N.N.E. and S.S.W. from the true meridian, corresponding with the strongly marked indentations of the coast, as well as the topographical features of the interior. One such great anticlinal form occurs within the region examined this year, with a corresponding synclinal; the axis of the former was found to be more or less overlaid unconformably by rocks containing fossils of Lower Silurian age, none of which were of less remote antiquity than such as are attributed to the horizon of the Upper Potsdam group.

The axis of this anticlinal runs in a moderately straight line from Cape Pine on the south coast, to Conception Bay, the Laurentian gneiss forming a nucleus to that part of the peninsula, and coming up from below the intermediate series, occupies more or less of the surface from the vicinity of the Renews Butterpots to the shores of Conception Bay between Holyrood and Manuel's Brook. The newer or great intermediate series, which flanks this Laurentian nucleus, was found on the peninsulas of St. John's and Ferryland to show a general dip to the eastward, although making many minor undulations; while on the peninsula between Conception and Trinity Bays the inclination is reversed, being nearly uniformly westerly, making many repetitions of the same strata, however, as on the opposite side of the fold. Corresponding with

this great anticlinal, the measures of the intermediate rocks, as seen at parts of the eastern coast of Placentia Bay, appear, by the generally eastern dip which they present, to indicate the axis of a synclinal trough to run from Trinity Bay in the direction of St. Mary's Bay. In Placentia Bay, gneiss is once more brought to the surface apparently by a great dislocation, where it forms a high and rugged range of hills and mountains from the Ragged and Merasheen Islands to Clode Sound in Bonavista Bay, and occupies a breadth of country between Black River and Piper's Hole of upwards of 7 miles. This range of hills is flanked to the westward by rocks of the intermediate series, the general attitude of which, becoming nearly horizontal or gently undulating on their course westerly, spreads over a vast area of country, exhibiting in that direction, as viewed from the higher elevations, a great plain as far as the eye can reach, broken only by one or two lofty isolated peaks (called tolts), which rise abruptly for a height of upwards of 1000 feet over the general level.

Rocks of Lower Silurian age were found reposing on the upturned or corrugated edges of the older systems, usually in depressions on the axes of undulations, frequently in a perfectly horizontal attitude, and, with but few exceptions, rarely showing a dip from the horizon of more than 10° or 12°. These are arranged in the form of elongated narrow troughs, extending lengthways in the same direction as the axis on which they rest.

The region examined would thus appear to be exclusively composed of the lowest members of the Palæozoic series; the newest of which is distinctly unconformable with the other two, and which contains organic forms recognised as belonging to the lowest parts of the great Silurian system.

The order of superposition would thus be in the ascending order:—

1. Laurentian series.
2. Intermediate ditto—Huronian.
3. Lower Silurian ditto—Potsdam, Upper and Lower, or Primordial.

In describing the character and distribution of these formations, I shall for the present confine myself as much as possible to generalities, reserving the more minute particulars until the collection of fossils and minerals has been properly

examined, when I shall be prepared to report more fully with confidence.

1. Laurentian System.

This system is extensively displayed in Newfoundland, and has materially contributed to produce the remarkable geographical and topographical features which the island presents.

Coming to the surface in a succession of parallel anticlinals, all trending about N.N.E. and S.S.W., at intervals more or less widely apart, gneissic rocks form the principal ranges of hills and mountains from one side of the island to the other (which, it is supposed, will all or chiefly prove to be of Laurentian age when more fully examined). In a report of mine addressed to Sir W. E. Logan, in 1865, a description is given with some detail (see Report for 1864-65) of the distribution and general character of these Laurentian rocks in the great northern peninsula; and further observation has tended to confirm what from the first was suspected, namely, that the same formation extends in a tolerably straight line from that peninsula to Cape Ray, constituting the Long Range mountains. Subsequent observations, together with information from reliable sources, seem to show that the same or similar gneiss is several times repeated between the western and eastern shores, two of which repetitions came within the region of last summer's exploration, as already stated.

The gneiss of the Conception Bay anticlinal was first observed immediately above the bridge over Manuel's Brook on the Bay Road, the valley of which brook nearly marks the eastern boundary of the formation, bearing in a general course a little eastward of south (true). The rock in the bed of the stream is mostly of a pale red or pinkish colour, rather fine grained generally, hard and compact in texture, bearing much the aspect of syenite, the layers of stratification very obscure. The hills, however, which rise immediately to the westward of Manuel's Brook display a variety of lithological character, having some heavy masses of a greyish quartzite, with some hard silicious slate, intermingled and entangled with the gneiss, giving ample evidence of stratification, although much contorted and broken.

From Manuel's Brook, the high land to the westward appears to be all or chiefly of this formation, till within a short distance of

Holyrood at the head of the bay, and it will probably be found on further examination to extend in a southerly direction, forming a belt of greater or less breadth, through the heart of the St. John's peninsula to the Renews Butterpot, where it would appear to terminate, and which, according to Professor Jukes, is of syenite and porphyry wrapped around by the St. John's slates.* Great masses of granite or syenite are intruded through these rocks at various parts, one conspicuous instance of which occurs at Indian Brook, a little westward of Kelligrews, near the head of the bay, where a beautiful and endurable quality of building stone can be easily procured. The syenite of both the Holyrood and the Renews Butterpots is probably also intrusive.

In Placentia Bay, where the second great exhibition of gneiss occurs, a great intrusion of granite was observed to run through Sound Island on its western side from end to end, in a course about N.N.E. (true), striking the mainland opposite, and thence on to the valley of Black River. From Black River to the westward the coast sections and mountains are of gneiss, showing many intrusions of eruptive rocks, to the extreme head of Piper's Hole; and there is a fine display of the formation in the rapids and falls of the Piper's Hole river for about 2 miles up its course, at which distance the gneiss was observed to terminate, and is succeeded by slate and quartzite, supposed to be about the base of the succeeding series. The breadth of country occupied by the formation, at this part, would thus be on an average about 7 miles, where it forms a range of lofty and precipitous mountains trending in the direction of Clode Sound in Bonavista Bay. In their southern course the same rocks appear to run along the Ragged Islands and the western shores of Merasheen Island, and thence beneath the waters of Placentia Bay.

In mineral or lithological character these rocks do not appear to differ in any great degree from those of the Laurentian series, described in my Report of 1864-65, p. 5, as occurring on the great northern peninsula, although peculiarities may be found to exist, when placed in the hands of a chemist or mineralogist, which I have been unable to detect. In the meantime, therefore, I would beg to defer entering into minute mineral description, until an opportunity offers of submitting the specimens collected

* See Jukes's 'Geology of Newfoundland,' p. 64.

to chemical analysis. On page 9 of the Report already referred to, an account is given of the economic minerals known to exist in rocks of Laurentian age in Canada, and that there these minerals or metallic substances are usually found in connection with great masses of crystalline limestone. It is also recorded that, with the exception of some small indications of specular iron and copper pyrites, no metallic ores had been seen in that formation on the northern peninsula. Hitherto the only evidence I have had of the presence of the part of the system to which the crystalline limestones belong, in Newfoundland, has been in the valley of the Codroy River and on the southern side of St. George's Bay; fragments of white crystalline limestone, spotted with graphite, having been frequently seen in the former, while at the latter magnetic iron was found with labradorite. The remarks applied to the rocks of the northern peninsula, probably apply with equal force to those of Conception and Placentia Bays.

2. The Intermediate System.

Supposed to be the equivalent of the Huronian of Canada.

Early in the year 1864, when on a visit to Topsail in Conception Bay, I was immediately struck by the abrupt change of stratigraphical character which presents itself on leaving the cliffs of the mainland and approaching the sea margin; and it occurred to me at once that the rocks skirting the shore and forming islands in the bay were of a different age to those of the mainland, and further that the former rested unconformably on the latter. The rocks of the cliffs and mainland generally were observed to be all more or less altered, and usually greatly tilted, sometimes quite vertically, or contorted in such a manner as to present a variety of dips in different directions; whereas the formation which skirts the shore showed but little disturbance, except where brushed up against the rocks of the cliffs, afterward sloping at a very moderate angle towards the sea. These first impressions have now been fully confirmed by the investigations of last summer, the newer formation having been repeatedly seen in Conception and Placentia Bays reposing on the upturned edges of the intermediate series; and further, the collection of fossils made during the season at various

parts, but in particular at Great Bell Isle in Conception Bay, tends to prove that the more recent of the two sets of rocks lies at the very base of the Lower Silurian system. It thus became obvious, that to whatever group or system already recognised the older of the two formations might be regarded as equivalent, there was at all events a vast difference in age between them; and I have all along been inclined to suspect that careful investigation would prove the lower slates and sandstones of St. John's to belong to the horizon of the Huronian system in Canada. Lithological resemblances alone may be admitted as of secondary importance in comparing rocks situated geographically very remotely from each other; but no one could fail to observe that such resemblances *did* exist, in some parts of the formation, in a very high degree, and that many of the mineral and stratigraphical peculiarities which apply to the Huronian rocks of Canada will likewise apply to those of the peninsula of Avalon. Recently, however, a great step in advance has been made, by the discovery of organic remains within these older rocks, which, until last summer, were supposed to be barren of such contents. The Rev. Mr. Harvey of this place had the good fortune to find the first well-defined specimen of these organic forms; and they, with others subsequently obtained, will doubtless be of inestimable service in finally settling the question of horizon. I have long had some obscure forms in my possession, collected in the neighbourhood of St. John's, which were suspected to be organisms of a low type, but which I could not venture to pronounce to be such without palæontological reference. Since Mr. Harvey's discovery I have obtained many more, all apparently of the same low order of existence; some of them so much resembling forms described by Sir Roderick Murchison, Jukes, Salter, and others, as peculiarly Cambrian, that there seems but little reason to doubt that the rocks of Avalon are the representatives of that system.*

In order to make the relation and succession of the formations intelligible, I have constructed two sections, supposed to intersect the country,—one from St. John's, at the entrance to the harbour,

* The forms in question were supposed to resemble the *Oldhamii* of Bray Head, but were pronounced upon examination by the late E. Billings to be undeterminable. He doubted their organic origin altogether. At a later date, however, fossils of a very low type were found, which Mr. Billings describes and names *Aspidella terranovica* and *arenicolites*.

to the northern side of Great Bell Isle in Conception Bay; the other from the cliffs at Topsail Head, across Bell Isle, and on to the islands of Harbour Grace.

Referring to Section 1, the order of superposition in the lower formation would appear to be as follows, in the ascending order, the base being at Portugal Cove in Conception Bay; but as there are many repetitions of the same strata, and a large portion of the country is concealed by superficial deposits of gravel and boulders, the statement here given must be regarded only as an approximation to the reality:—

	Feet.
a. Diorites, quartzites, and jaspery bands—some of the latter of a reddish colour with hard greenish slates. At Topsail there is probably some additional lower strata, and there is one very remarkable stratum or vein of vitreous white quartz, which runs parallel with the stratification, and exposes a thickness of from 10 to 12 feet, but may be more, the unconformable rocks occupying the margin between it and the shore	1300
b. Slate conglomerate and slate without pebbles, the matrix of the conglomerate chiefly of a dark greenish colour and trappean aspect, enclosing pebbles of quartz, many of which are white and some grey, syenite, red and brown jaspers, slate, and occasionally drab-coloured or yellowish chert; vertical cleavage sometimes observable, and at times cutting indifferently through both pebbles and matrix, whilst at other times the pebbles are loosely imbedded and break out whole from a blow of the hammer	1650
c. Green, purple, pinkish or red slates in frequent alternations; the texture of these slates is generally extremely fine, and in some cases they approach in hardness to jasper or chert. The fracture is often conchoidal, and the imperfect cleavage parallel with the bedding; but in many instances the rock has a good cleavage, oblique or at right angles to the stratification, and is well adapted for roofing purposes. The exposed surfaces weather for the most part of a yellowish white. The fossil forms, supposed to be of the genus *Oldhamia*, were found in these slates towards the top	3300
d. Dark brown or blackish slates of St. John's, with ripple mark very distinctly displayed upon some surfaces, and in which some obscure organic remains have been found resembling the fossils found in *c*, and another supposed to be the shelly casing of some description of Annelid.*	

* *Arenicolites.*

	Feet.
The cleavage of this slate is sometimes very regular, oblique or at right angles to the bedding, but in parts it also cleaves parallel with the stratification. Towards the top there are frequent layers of hard, fine-grained, greenish sandstone interstratified, not usually over 6 or 7 inches in thickness	2000
Signal Hill Sandstone.	
e. Greenish or grey fine-grained sandstone, very hard, with conchoidal fracture; difficult to work, but used to a large extent as a building stone, in beds varying from 1 to 3 feet thick	1300
f. Dark red sandstone, hard and tough, in strong, massive, irregular beds, from 2 to 3 feet thick, passing into a fine conglomerate at the top; the whole reticulated with veins of white quartz	1320
g. Red conglomerate, the pebbles of which are chiefly white quartz, but with occasional pebbles of brown or red jasper, syenite, or gneiss and slate. The pebbles vary in size from a pea to a 6-lb. cannon ball	500
Total	11,370

By far the greater portion of the whole peninsula of Avalon is occupied by the members of this great system. It extends from the shores facing the Atlantic in the districts of St. John's and Ferryland, entirely across the peninsula at its northern extremity, and into the interior farther south over a breadth in many places of 10 or 12 miles, the general dip being towards the sea. The upper parts or Signal Hill sandstones of Jukes (*e, f, g* of the section) hold the coast for the most part from Torbay to Cape Broyle and Ferryland Head; the strata, between the former and latter of these places, showing a repetition of undulations which were long since described in detail with great accuracy by Professor Jukes.* The slate (*c* of section) keeps the coast exclusively to the southward to Cape Race, and round to the westward to Trepassey. At Cape Pine, and on the western side of Trepassey Harbour, the rocks of the cliffs are of a more massive character, and are probably the equivalents of *a* or *b* of the section, and at the former place these can be plainly seen, when off the coast, to roll over in an anticlinal form, and the dip on the west side to become south-westerly. The axis of this anticlinal would thus run from Cape

* See Jukes's 'Geology of Newfoundland,' p. 62.

Pine in a direction a little east of north into Conception Bay, flanking the Laurentian nucleus of the peninsula on the west side, as it does on the east and south.

In the bed of the brook in the eastern cove of Holyrood, at the head of Conception Bay, the rock is slate with a good deal of quartzite, the latter often of a yellowish colour, with surfaces occasionally pitted over by rounded water-worn holes. Westward of the brook the sharp conical hills of Holyrood appear to be chiefly porphyritic, but in parts show a stratified structure. When the stratification is visible, the strike appears to be nearly true north and south and the attitude vertical, intersected also by cleavage or joints nearly or quite at right angles. These rocks were supposed to be the equivalents of *a* of the section, but may possibly be somewhat lower. At Holyrood South Gut the rock is chiefly diorite or porphyry, with much epidote and chlorite, and some occasional bands of quartzite, the prevailing colour of the whole reddish or dark brown, which are succeeded to the westward by a mass of slate, seen upon the road for the greater part of the way to Harbour Main. At Holyrood South Gut, where some indications of copper present themselves, an attempt at mining has been going on for some time, but the result hitherto does not appear to have been successful. Between Salmon Cove and Cat's Cove a mass of syenite presents itself, which was supposed to be intrusive, and the rocks of the peninsulas on either side of Gastries Bay are much altered, mostly assuming the character of porphyry or amygdaloid. At Burke's Point, however, in Collier's Bay, the rock is evidently a conglomerate, being composed of a greenish and reddish crystalline matrix, with rounded pebbles of various colours from 1 to 5 inches in diameter inlaid, giving the smooth water-worn surfaces a rude resemblance to mosaic. On fracture the rock breaks indifferently through pebbles and matrix. Approaching towards James's Point, the rock passes into an amygdaloid containing numerous small white specks or crystals, supposed to be of feldspar. The cliffs on the western side of Collier's Bay approaching Turk's Gut are also either of amygdaloid or porphyry, the general colour being usually green but spotted with red, or of a greenish grey with spots, patches, or strings of white calc-spar, epidote likewise being diffused somewhat largely; but the hills inland, which range towards Brigus, are chiefly of slate with bands

of quartzite, which, striking exactly parallel with the indentations of the coast, dip at a very high angle to the north-west. Among the amygdaloids and porphyries of this part of the coast, there are frequent indications of the presence of copper ore,—usually in the form of a grey sulphuret. Mining has been attempted at Turk's Gut and at Cross Gulch, near English Cove; but both places have long since been abandoned.

The country between Holyrood and Collier's Bay would thus appear to represent the basic rocks of the section, in no case bringing in higher measures than the lower parts of *c*, but repeating the same strata either by undulation or dislocation several times. Between Bull Cove in Collier's Bay and Brigus Harbour the lower members of the formation were seen, consisting in great measure of quartzite with slate, in many parts thickly reticulated by white quartz veins, dipping in a north-westerly direction from 65° to 70°; and these are overlaid towards Brigus Harbour by alternations of reddish and green slates, showing a corresponding dip. At Brigus the country shows a set of sharp, bold, precipitous, parallel ridges, divided by narrow valleys, running generally about N. 42° E., S. 42° W., showing escarpments to the south-east, the rocks dipping north-west from $<$ 45° to 50°. The rock of these ridges is chiefly a greenish or grey clay slate, frequently somewhat silicious, enclosing occasional solid bands of grey quartzite. In certain parts of their run these slates have a regular and perfectly parallel cleavage, striking N. 14° E., S. 14° W., and quite vertical, in which cases they appear to be of a quality well adapted for roofing, or other economic purposes. Following the western shores of Conception Bay, from Brigus to Carbonear, the whole country appears to consist of the middle or upper members of this formation, division *c* occupying the greater amount of surface, coming up in a succession of undulations corresponding with the curiously indented features of the coast, but invariably presenting a north-westerly dip, frequently at a high angle. The high land between the North and the South Gut at the head of Bay-de-Grave was not visited, but from the massive character of the beds, seen from the road, they were supposed to belong to the upper members of the section, probably *e* and *f*. The coast to the northward of Carbonear I as yet have had no opportunity of examining, but reference to Professor Jukes's

'Geology' will show that the slaty parts of the formation occupy the country in that direction as far as Flamboro' Head and Bay-de-Verde, where they are seen to pass below the sandstones and conglomerates of Signal Hill. This latter feature I observed myself in 1864, and was then inclined to suspect the occurrence of a great anticlinal axis running about the centre of Conception Bay, and that the Signal Hill rocks outside of Old Perlican were about to make a sharp turn to form a synclinal in Trinity Bay.

On crossing the country from Holyrood to Salmonier, and thence on to St. Mary's Harbour on the east side of the bay of that name, the rocks were found to resemble those of this formation at one or other of its divisions, the slaty parts of *c* being most largely developed south of Salmonier; but a great tract throughout the region is concealed below marshes, barrens, or woods. The same remarks apply equally to the country between Salmonier and Colinet; but on approaching towards the latter place a change of formation was observed which will be described hereafter as forming a part of the succeeding series.

Crossing over to Placentia Bay, a succession of the lower members of the formation was observed in Great Placentia Harbour. The northern side of the north-east arm of that harbour consists almost altogether of porphyry, with epidote largely disseminated, and intersected by cupriferous quartz veins; but at the Seven Islands the rock is a greenish or dark grey slate with bands of greenstone or diorite, which show a dip to the south-eastward of about 60°. On the north side of the same arm, towards the head, there is an exposure of hard red slate, with some bands of quartzite; while on the south side, and nearly opposite, the rock is a dark green slate, both dipping nearly in the same direction, a little southward of east, at a pretty high angle. The southern shore of the north-east arm is of diorite, with small calcareo-quartzose veins, which occasionally hold galena, together with a brown or yellowish-green mineral, supposed to be blende. At the point of the peninsula between the north-east and south-east arms, immediately opposite the Town Point, the rock is a hard, dark red slate, interstratified with beds of compact reddish and dark grey quartzite, which is again overlaid by green silicious slate. There are also some alternating bands of red, purple, and green beds, upon some surfaces of the latter of which peculiar markings were

observed in high relief, which possibly may be of organic origin. The dip of these beds is S. 40° E. < 30°. Between the point of the peninsula and McDonald's Cove alternating masses of red quartzite, red and green slates, diorites, and some beds of yellowish chert occupy the northern shore of the south-eastern arm; and these are succeeded at Dixon's Hill, Verron's Island, and McDonald's Cove, by slate conglomerate, the pebbles of which are mostly well rounded, consisting of quartz, chert, a few blood-red jaspers, syenite and slate, imbedded in a coarse-grained crystalline matrix. On the western side of Dixon's Hill this conglomerate seems to pass into a porphyry, the change apparently being occasioned by the intrusion of greenstone, which may be seen running across the strata in a nearly due north and south course. The same conglomerate shows itself again farther west at Cape Verde. These rocks are evidently the representatives of *a* and *b* of the section. Near the head of the south-east arm at Salmon Island, and at the falls of the stream which empties itself into the arm at its head, red and green slates, with an occasional strong bed of conglomerate, were seen to dip S. 87° E. < 23°, which answers as the equivalent of *c*.

Following the coast of Placentia Bay, south of Great Placentia, by what is termed the Bay-shore Road, the rocks crossed are chiefly the slates of *c* until approaching the Big Barrachoix Brook, where some red and green strata, for the most part of hard compact sandstone with slaty divisions, present themselves in considerable disturbance. These resemble the upper divisions of the formation *e* or *f*. At Ship's Cove a considerable volume of conglomerate, which represents *g*, comes up associated with red and greenish strong bedded sandstone and some slate. Continuing southward from Ship's Cove, the same or similar rocks are crossed, until getting towards Gooseberry Cove, where there is a change of character, the higher elevations being spread over by a bright red slate, spotted and patched with green, which was at once suspected to rest unconformably over the upturned and contorted measures previously seen, and to belong to a more recent formation. Between Gooseberry Cove and Distress great confusion is displayed in the cliffs by repeated intrusions of greenstone, which here, in many cases at least, appear to affect both the upper and the lower formations, and it frequently happens that it is

extremely difficult to distinguish the one from the other, in consequence of the resemblance of colour, which is often red or green in both; but the difference is nevertheless very perceptible on close scrutiny, both in mineral constituents and even in colour, as well as in general character and attitude. The colour of the upper rocks, whether red or green, is invariably bright, in the red parts almost approaching vermilion, while in the lower formation the red is always dark, at times becoming nearly umber. The lower rocks were observed in all cases to be pitched at a very high angle to the horizon, the prevailing inclination being to the eastward, while the upper formation, except where disturbed by eruptive intrusions, was either in a perfectly horizontal attitude, or only slightly tilted, chiefly pointing to the north-west or west. The strata of the lower formation, moreover, were peculiarly remarked for their *general absence of lime*, whereas the upper formation is nearly all more or less calcareous, especially in the lower members. Mica also, which prevails in many parts of the upper formation, seems to be singularly absent in the lower.

Travelling southwards the conglomerates and sandstones (*g*) were observed to come up in Angle's Brook, the heights on either side being capped by the red slates of the upper formation; but the latter are let down by a fault in Deadmen's Cove, where, on the south side of the disturbance, a set of red and purplish slates with yellow calcareous nodules are exhibited, overlaid by a red limestone holding obscure organic remains. This limestone is overlaid by bright red and green shales or slates, which, being supposed to be the equivalents of the variegated slates of Jukes, will be further described hereafter.

After leaving the country around Distress, where the red limestones with their associated bright red shales are spread over a considerably large area, and proceeding towards Branch, in St. Mary's Bay, a succession of barrens and marshes was crossed, where, with but few limited exceptions, no rock whatever was exposed; and the few exposures that do occur were too isolated to warrant any certainty of their age and position. Between 2 and 3 miles from Distress, after leaving the red rocks, fragments of a conglomerate were observed occasionally strewed over the surface, which at the time was supposed to resemble the slate conglomerate of Placentia, and the Green Hills of the watershed

were found to be of greenstone. After leaving that part and descending towards the valley of the Branch River, no rock was observed *in situ*, till within about 2 miles of the outlet of the Branch, when the red and green shales reappeared, and are exhibited in cliffs of moderate height upon the banks of the stream and on the sea-shore. These shales or slates contain numerous fossils, chiefly of the genus *Paradoxides*, and appear to me to be without doubt the equivalents of the variegated slates of Jukes.

What the age of the central greenstone of this region, or of the conglomerate indistinctly seen on the west side of the watershed may be, it is in the meantime impossible to say with certainty; possibly a subordinate anticlinal may affect the strata running towards Trinity Bay, and bringing up one or more of the members of the lower formation; or the greenstone may be a great intrusive mass which, stretching from near Cape St. Mary in a moderately straight line for Chapel Arm in Trinity Bay, would form the hills and highest summits of the watershed, including the Platform Hills, Castle Ridge, and Sawyer's Hills,—together with the hills farther north in the same direction.

Being unable, from circumstances over which I had no control, to examine the coast between Great Placentia and the La Manche mining location, I proceeded from the former to the latter place direct, and there recommenced the survey. At La Manche a set of hard green and occasionally reddish jaspery slates, with slate conglomerate beds, present themselves, supposed to be the equivalents of *b* and *c* showing a dip to the westward, which are succeeded by a set of hard red or brown altered sandstones at the south-eastern part of Little Southern Harbour, probably the representatives of *e* or *f*; but on the north-eastern side of the higher hills over the location, which are of greenstone or porphyry, a set of slates, much shrivelled and corrugated, show a dip about east by north at a high angle, and are succeeded on the higher elevations towards Rantom Cove in Trinity Bay by conglomerates, which so strongly resemble the rocks of *g*, that there is little doubt they belong to that horizon. These conglomerates and associated rocks were recognised by Professor Jukes farther north towards the head of Bull Arm, in Trinity Bay, there dipping to the north-west under variegated slates, being brought into

that position by an undulation.* At Bourdeaux Head, likewise, some similar strata were seen dipping about S.S.W., indicating the existence of a trough between that point and Little Southern Harbour. Many such flexures occur, in all probability, throughout the whole range over which the formation extends, and it will require very much more close investigation to follow out all these sinuosities with anything like minuteness or accuracy.

The rocks exposed on the western side of the granitic and gneissoid hills on the Piper's Hole River were also believed to be of this formation. They consist of a set of corrugated clay slates at the base, with some quartzite interstratified, succeeded by an altered conglomerate, which seems to pass often into porphyry, and which, from its low inclination, spreads over a very extensive area in the direction of Prince William Lake (of Cormack) or the head-waters of Piper's Hole River.

Although lime is rarely found in the beds of this series, the veins that intersect it are frequently calcareous, and in many parts are more or less charged with galena and other metalliferous substances. Veins of sulphate of barytes are also frequent in some parts of its distribution, and they were observed generally to occur near the contact of the higher formation. Many instances of calcareous veins may be cited as occurring at Placentia Harbour and on the bay shore, south from that place and between it and Distress; while at La Manche and Bourdeaux Head the veins are for the most part all more or less calcareous. The lode at the La Manche lead mine is chiefly of a pale pinkish calc-spar, often in the form of dogtooth spar, associated with transparent white or amethystine quartz crystals, sulphate of barytes, and other minerals; while at Bourdeaux Head the strata are intersected by enormous veins of opaque white calc-spar, in coarse rhomboidal crystals. At the latter place a vein from 4 to 9 feet wide of the latter description intersects the point from one shore to the other, bearing in a general course nearly due east and west. Besides the vein just mentioned, there are several others on Bourdeaux Island, and also at Come-by-Chance Head on the opposite shore of the bay of similar quality, all keeping a general parallel direction to each other.

Numerous dykes of greenstone or porphyry also intersect the

* See Jukes's 'Geology,' p. 90.

strata, which at the La Manche mine were observed to be themselves intersected by the lead-bearing vein; and it was remarked that the ore had a tendency partially to cease, or to disappear entirely towards the points of intersection. These dykes are not altogether regular in their course, or always parallel to each other, but the prevailing course is towards north and south. More particulars regarding the La Manche mine will be given under the head of economic materials.

3. Lower Silurian Rocks.

On Manuel's Brook a very coarse conglomerate may be seen, in strong and moderately regular beds, resting directly upon the syenitic gneiss of the valley above, dipping to the north $< 15°$, and forming a picturesque fall about 150 yards below the bridge on the Bay Road. Great boulders of the parent rock, many 2 or 3 feet in diameter and more or less angular, are imbedded in this conglomerate at the immediate junction; but the size diminishes gradually as the strata accumulate, the average size of the largest being rarely greater than a man's head, and mostly rounded. The matrix of this conglomerate is chiefly a coarse sand composed of rounded grains of white quartz and reddish feldspar, cemented together in a greenish paste. Many of the rounded pebbles or smaller boulders imbedded are of a semi-translucent bluish quartz, or of jaspery character of a greenish tinge. About 400 yards below the bridge the conglomerate is overlaid conformably by a set of dark brown or blackish shales, with a very fine lamination coinciding with the bedding, which, with some hard calcareous beds interstratified, hold the banks of the brook until within a short distance of its exit into the bay. At Topsail Head a grey compact limestone in strong solid beds from 1 to 2 feet thick, showing a vertical thickness of about 100 feet, together with some shales interstratified, butts up against the vertical strata of the cliffs above, and presents a dip of from 30° to 40° towards the sea-shore. The limestone is overlaid by dark brown finely-laminated shales which skirt the shores of the bay in front, and in their northern strike run under the surface of the water, within half a mile of Topsail Head. A fault is perceptible at the contact of the limestone with the older strata, running about N.N.E. and S.S.W.,

which may account for the non-appearance of the conglomerate of Manuel's Brook at that part, a segment of the outcrop having seemingly been cut off by that dislocation, and being upthrown on the eastern side, has long since been denuded and disappeared.

Following the terminal outcrop round the shores of Conception Bay, shales, corresponding with those seen on Manuel's Brook, are occasionally exhibited on the sides of the road and on the sea-coast, always presenting a gentle dip towards the northward. The tract, however, between the sea-coast and the hills at this part, being thickly covered by drift material of coarse gravel and sand, and the surface strewn over by gigantic boulders, the stratification is in a great measure concealed. After leaving Topsail, no solid beds of limestone were observed until getting round the extreme head of the bay beyond Holyrood; but the extremities of the peninsulas outside of Harbour Main exhibit some very calcareous strata, dipping at an angle rarely exceeding 10° towards the north or east. Some of the limestone at this part is in beds of less than a foot thick, of a dark grey colour, with obscure organic remains, exactly resembling, except in regard to thickness, the limestone of Topsail; while there are other beds of apparently higher strata, of a red colour, much more massive, sometimes upwards of 2 feet thick. The thin grey limestones are interstratified with some grey or greenish calcareous shales, which, near the junction with the older formation, are in a good deal of confusion, apparently being thus affected by an intrusion of trap. The red limestone alternates with some hard solid beds of reddish calcareous sandstone of fine grain, and bright red shales, at the summit of which are some reddish, hard, calcareous, nodular beds, the nodules being more calcareous than the matrix, and which, assuming a yellowish colour, give the exposed surfaces a spotted appearance resembling a conglomerate. The junction of the two formations at this part is rather obscure, but the position is nevertheless pretty well marked by a depression on the land, or small dingle, which runs straight across the point, the altered rocks on the west side rising in abrupt hillocks of corrugated strata, while on the east side the surface is strewn over by large angular blocks of grey limestone. Proceeding northwards, these rocks, which usually present more or less of a bright red appearance, may be seen to occupy the extreme points of Bacon Cove and Collier's Bay, and at

Brigus South Head there is a fine exposure, where the unconformable relation of the upper with the lower formation is manifested in the most unmistakable manner. The upper rocks occupy the coast from Brigus South Head in a southerly direction for a distance of about three-quarters of a mile, with a breadth averaging from 10 to 15 chains, inside of which there runs a deep narrow depression, with a small pond * and some marshy ground running exactly parallel with the shore. This depression marks the junction, and in it, at several places, the exact contact is visible; and the limestones and red shales may be seen butting against the corrugated edges of the older formation, and dipping in the opposite direction. From this depression an escarpment arises facing nearly due west to the height of about 60 feet, consisting of grey or greenish beds of limestone, with bright red and sometimes greenish slates or shales, which at the outcrop dip due east $< 63°$. But this high rate of inclination decreases towards the sea. These rocks are intersected by a cleavage independent of the bedding, which is particularly displayed in the red slates, running exactly at right angles to the dip and inclining to the north 60°. The greater part of the surface between the terminal escarpment and the sea-shore is taken up by the bright red slates, but the cliffs of the coast itself are of alternating beds of green and red strata, in which the former colour prevails, with some thick, hard, arenaceous bands interstratified.

Following the strike of the formation to the northward, the same rocks were seen to touch upon the extreme outward point of the northern head of Brigus; and it was supposed they might also touch upon the outer points between Bay-de-Grave and Spaniard's Bay; thence running below the waters of Conception Bay, they are no more seen on the mainland.

The evidences above described seem clearly to indicate that a trough of the newer formation rests on the crown of an anticlinal arch of the older series in Conception Bay, the base of the former, at some parts at least, coming in direct contact with gneiss of Laurentian age.

A section of the measures from Topsail Head across Great Bell Isle, in the direction of Harbour Grace Island, would therefore probably be nearly as follows:

* Red Rock Pond.

SECTION No. 2.

		Feet.
P, c.	Coarse conglomerate of Manuel's Brook	50
„	Black and brown shales of ditto, with calcareous beds ..	250
P, l.	Topsail limestone, containing fossils, mostly very obscure, amongst which *Salterella*, *Crania Labradorica*, and fragments of a trilobite, have been recognised by Mr. E. Billings—all emphatically pronounced by him to be of Potsdam age	100
P, s.	Brown, black, red, and green slate or shale, with beds of limestone. With the exception of the former quality, these rocks are concealed below the water on the line of section, but the supposed equivalents are exposed on the western side of the bay, and other localities, and are probably the same as the variegated slates of Jukes. The *Paradoxides* beds at Branch, in St. Mary's Bay, are supposed to be about the horizon of the upper part ..	858
P, k.	Kelly's Island sandstones and shales, given below in detail	720
P, x.	Little Bell Isle strata, with beds of sandstone and shale, and some calcareous bands at the base; but strata concealed between that island and Great Bell Isle for about 2¼ miles, with a dip supposed to average about 7° ..	1426
P, y.	Blackish very micaceous shales, with beds of micaceous, pale and dark grey or brown sandstone, with numerous fossils, among which *Cruziana semiplicata* and other species are in great abundance, together with one or more species of *Lingula*, &c. These beds extend from the south shore of Bell Isle, at Lance Cove, towards the centre of the island	396
P, z.	A mass of greyish, granular, white-weathering sandstone, forms the upper stratum of Great Bell Isle, crowded with comminuted organic remains, chiefly of a species of *Lingula*	80
	Total, about	3880

A detailed measured section of Kelly's Island (*P, k* of section), from south to north, on the eastern end, consists of the following strata:—

ASCENDING ORDER.

	Feet.	In.
1. Clay cliff concealing the strata, probably shales, say ..	100	0
2. Black or dark grey shale	2	0
3. Pale greenish, fine-grained sandstone, in four strong beds, divided by partings of greenish argillaceous shale ..	25	0
4. Dark grey or brownish argillaceous shale, with thin beds of grey sandstone from 1 to 6 inches thick	30	0

	Feet.	In.
5. Beds of pale greenish grey sandstone from 1 to 2 feet thick, divided by dark grey or brownish argillaceous shales ..	20	0
6. Similar shale with thin-bedded sandstone	10	0
7. Similar beds of sandstone and shale in about equal parts ..	20	0
8. Solid beds of greenish-grey, fine-grained sandstone in layers of from 3 to 10 feet thick, divided by very thin partings of dark grey argillaceous shale	50	0
9. Dark grey argillaceous shale with thin beds of grey sandstone	12	0
10. A bed of greenish-grey sandstone	1	6
11. Dark grey or blackish argillaceous shale	0	6
12. A bed of grey sandstone	1	6
13. Black argillaceous shale, enclosing some hard argillo-arenaceous bands, one upwards of a foot thick	4	0
14. A mass of sandstone in irregular layers	10	0
15. Black argillaceous shale	10	0
16. A mass of hard grey sandstone weathering yellowish, with conchoidal fracture, broken up at the outcrop in irregular splintery fragments	7	0
17. Dark grey or brownish argillaceous shale	1	0
18. A solid bed of pale green sandstone, containing small scales of silvery mica	5	0
19. Grey argillaceous shale, with thin hard bands of sandstone	1	0
20. An uneven irregular bed of pale green sandstone, with small scales of silvery mica	1	0
21. Black or dark brown shale	6	0
22. Dark grey or brownish shale, with beds of ferruginous brown or dark grey sandstone from 1 to 6 inches thick, weathers of a rusty brown colour	10	0
23. Blackish shale, enclosing some thin irregular bands of grey sandstone, generally from 1 to 3 inches in thickness; but some beds a foot thick at parts irregularly ..	43	0
24. Thin-bedded grey sandstones, slightly calcareous, in beds from ½ an inch to 6 inches thick, interstratified with black or bluish argillo-arenaceous shale; small scales of silvery mica, abundantly sprinkled on the surface of the sandstones	17	0
25. Greenish-grey sandstones, with a large amount of silvery mica in small scales; beds from 6 inches to 1 foot thick, divided by blackish argillaceous shale in bands from 1 to 2 feet thick	9	0
26. Massive beds of greenish-grey sandstone, from 2 to 3 feet thick. Upper beds characterised by rudely circular-flattened concretions of same quality as the bed. These beds show a jointed structure, and the joints are frequently lined with calc spar. The rock also is slightly calcareous and contains silvery mica	33	0

	Feet.	In.
27. Grey arenaceous and argillaceous shale, with a few hard irregular layers, varying from 1 to 6 inches thick ..	12	0
28. Grey arenaceous shale, with some compact, hard, blackish beds of very fine-grained sandstone, from 6 to 18 inches thick	49	0
29. Grey arenaceous shale, with a band at the summit of dark bluish-grey sandstone of very fine grain, and with small specks of silvery mica	17	0
30. Black or dark grey argillaceous shale; portions very micaceous; fine small scales of silvery mica	17	0
31. Dark grey or blackish shale, with a few bluish-coloured, hard, close-grained bands, from 1 to 6 inches thick, interstratified; with a remarkable bed at the summit from 2 to 3 feet thick, which is made up of a set of irregular concretionary masses, usually of a flattened oval shape, which lie rudely parallel to the strata above and below, but are themselves bent and contorted, the interstices between filled up with black shale	13	0
32. Black or dark grey shale	1	0
33. Irregular beds of fine-grained greyish sandstone	2	0
34. Grey shale, with thin, hard, fine-grained silicious beds interstratified from 2 to 6 inches thick; strata very ferruginous, and mostly weathering of a rusty brown colour	58	0
35. A stout band of grey sandstone	1	0
36. Dark grey shale, with thin hard bands from 1 to 2 inches thick	20	0
37. Grey sandstone	2	0
38. Alternations of grey argillaceous shale, with thin layers of sandstone from ½ an inch to 1 inch thick	1	8
39. Grey sandstone	2	0
40. Brown ferruginous shale, with some very thin hard beds interstratified	8	0
41. A strong bed of grey sandstone	1	6
42. Thin-bedded, flaggy, greyish sandstones, interstratified in about equal amount with grey argillaceous shale	30	0
43. A strong solid band of grey sandstone	3	0
44. Alternations of greyish shales and sandstones	20	0
45. Massive beds of grey sandstone	15	0
46. Ditto, ditto	10	0
Total	712	8*

* Since those strata were measured, they have been found near the middle part of the section to be very fossiliferous, one of the most characteristic of which fossils is a very small *Lingula*, *L. Billingsonia* (Whiteaves).

The strata of *P, y* and *P, z*, from the shore near Lance Cove, Great Bell Isle.

ASCENDING.	Feet.
1. Black or dark brown shales, with thin beds of sandstone from 2 to 6 inches thick, of a grey colour on fracture, mica being thickly disseminated in both shales and sandstones, and especially at the division of the harder members	20
2. Thin bands of sandstone like the preceding, weathering a rusty brown colour, and divided by layers of black shale ..	6
3. A hard strong bed of grey sandstone, with conchoidal fracture, irregularly bedded,—average thickness about	4
4. Alternations of black shale and sandstone towards the top of the vertical cliff	60
5. A heavy mass of strata, mostly sandstone, forms the crest of the cliff	10
6. Alternations of very micaceous grey sandstone and shale, the former mostly thin bedded, varying from 1 to 6 or 8 inches, with *Cruziana* in great profusion on many surfaces. Nodular concretions holding *Lingulæ* among the shales	100
7. The upper strata are a good deal concealed, but beds of sandstone occasionally crop out on the bed and banks of a small brook near the line of section, some of which is of a pale yellowish colour, in some cases nearly a foot thick .. say	196
8. The upper stratum is also in great part concealed, but large angular-jointed fragments of it are abundant on the surface all along the summit level, which are clearly in place, or only slightly removed. Some of these beds appear to be from 1 to 2 feet thick, are rather coarsely granular, of a greyish or greenish colour on fracture, and contain crowds of organic remains, chiefly a species of *Lingula* .. .. say	80
Total	476

The unconformable red rocks come against the porphyry of the cliffs a little south from English Cove, on the west side of Collier's Bay, and keep the coast towards the head of the bay, dipping west < 26°, which would appear to show here a fold of the newer formation. Its spread over the country inland was not ascertained, as it is in great measure concealed under woods, but it probably forms a small narrow patch or trough between the coast and the high hills to the south-west,—pointing in its longer axis towards the head of St. Mary's Bay.

Passing southwards into St. Mary's Bay, the formation was again recognised on the banks of the Colinet and Rocky Rivers. The latter river pours its waters into a long narrow arm of the sea,

over a fine cascade of 40 or 50 feet, above which, after passing several smaller falls and rapids for a short distance up its course, the stream becomes smooth and deep, and continues so for many miles, bearing upwards in the direction of Trinity Bay. At the lower fall there is a disturbance observable in the cliffs, and there is difficulty in consequence in determining whether the rocks at that part belong to the upper or the lower series; but in the salt-water arm below, the resemblances of the beds are so strikingly similar to the Kelly's Island group (*P, k*), that little or no doubt can be entertained of their identity. At the head of the great fall, just above the bridge, the rock is composed of hard massive beds of a greenish or grey sandstone, some of which are upwards of 3 feet thick, with divisions of a reddish shale, which dip S. 72° E. < 26°. These are overlaid by thin alternations of sandstone and arenaceous shale of not more than an inch in thickness up to the edge of the cascade, which is an enormous bed of sandstone from 4 to 5 feet thick. Numerous veins of white quartz run in the strike of these beds, and they are intersected by a vertical cleavage at right angles to the dip. Ascending the valley of the river, the rock, where exposed, was found usually to be a grey or greenish slate in nearly a horizontal attitude, till about 2 miles up the course of the river, where a set of beds of grey fine-grained sandstones occur about 12 feet thick altogether, which dip about N. 50° W. at a very low angle. Above this sandstone the only rock that was seen from 3 to 4 miles farther north was some horizontal slate or shale.

In the salt-water arm below the fall, the strata consist of red and green shales, with beds of grey or greenish sandstones, varying in thickness from 2 inches to a foot, or 18 inches, and one remarkable bed of black shale, about half-way between the falls and the outer end of the arm, contains a set of concentric concretions of sandstone, of precisely the same description as the bed noticed in the Kelly's Island section. At the outer end of this arm the rock is a red shale with beds of calcareous sandstone. These rocks show a succession of gentle undulations, on the banks of the arm, and the red shales outside slope at a low angle to the westward. At the mouth of the Colinet River, which falls into Colinet Bay, about half a mile east from the Rocky River Arm, there are a few exposures on low cliffs, not often exceeding 5 or 6 feet high, of greenish shale dipping south < 5°.

Following the western coast of St. Mary's Bay, southwards from Colinet, we find at John's Pond, near the entrance to North Harbour, a set of greenish shales corresponding with those at Colinet, in which some obscure organic forms occur, the shales intersected by small veins of pure white calc spar; and farther south, at Cape Dog, on the east side of the cove of that name, the rock is a soft red and green shale, holding *Paradoxides*, and having associated thin bands of a greenish-grey or red limestone interstratified. Large angular boulders of red fossiliferous limestone are strewn along the beach also at Cape Dog, derived doubtless from more massive beds of that rock outside in the bay. At this place the shales dip to the south-east, but towards the extreme point of Cape Dog they become much twisted and dislocated by an intrusion of amygdaloidal trap, rendering the normal dip difficult of detection. On the west side of Cape Dog Harbour the rock is a dark blue or blackish shale or slate, with smooth glossy surfaces, which shows a dip to the north-west; but here again there is much disturbance from the intrusion of trap dykes of vesicular character, the vesicles filled with white calc spar; one of the dykes is cut by a vein of calc spar holding minute specks of copper ore.

The state of the weather whilst I was at Branch prevented the examination being continued along the coast between that place and Cape Dog; but I am inclined to suppose, from such information as I could obtain, that it is chiefly or altogether overlaid by members of the upper formation. The cliffs of the seashore at Branch, and on the banks of the river, varying in vertical height from 30 to 50 or 60 feet, are composed of variegated red, green, and purple soft slates or shales, which at the top pass nearly altogether into red slates, the general dip of which is N. 75° W. < 7°. These shales are intersected by a cleavage parallel with the strike of the bedding, N. 15° E., S. 15° W., which, cutting the strata obliquely, underlies in the same direction < 65°. Another less regular cleavage intersects both the bedding and the oblique cleavage at right angles, dividing the rock into splintery fragments, so remarkably fragile that there is difficulty in procuring a specimen of any required size or shape. These shales are filled with the fossil *Paradoxides Bennetii;* but it is nearly impossible to break out an entire specimen, in consequence of the manner the rock is cut up by the above-mentioned cleavages.

The fossils are usually more or less distorted, lying irregularly quite parallel with the bedding, and chiefly in the green and purple parts, but sometimes in the red, in which case it was observed that the spot surrounding the fossil had invariably the green tinge. The shales here were observed to be traversed by a set of parallel trap dykes, running N. 53° W., S. 53° E., one of the largest of which was found to be 10 feet wide. Both dykes and strata appear subsequently to have been broken by small faults, rarely exceeding 20 or 30 feet, throwing the whole upwards towards the north-east. The strata are slightly altered at the contact, becoming harder, but very brittle, and often of a brownish colour. No solid beds of limestone were seen anywhere near Branch, but large angular blocks are abundantly strewed over the beach, only to be seen at low tides. These consist of a red limestone with fossils, among which the obscure form of a shell resembling a *Lingula* was found at one place near Beckford's Point, on the north side of the roadstead. At Branch Head there is some black shale containing spherical-shaped concretions, sometimes as large as an 18-lb. cannon ball, but often of much smaller size. Round the head the red strata again come out in the coves, dykes of greenstone forming the principal projections, until getting to the south side of Gull Cove, when strata resembling those of Branch Head are reintroduced, holding similar concretions and nodules, and containing some solid beds of a black colour and very fine texture, said to be used as hone-stones.

A small trough of what was supposed to be the Kelly's Island portion of the formation was likewise seen on Holyrood Pond on the east side of St. Mary's Bay. The lower beds consist of green shales with hard, green, compact sandstone of from 1 to 10 inches thick, dipping S. 70° E. $< 15°$, advancing on which dip to the northward the strata accumulate in alternating beds of shale and sandstone, some of the latter upwards of 3 feet in thickness and terminating in a cliff of sandstone in strong layers, divided by red and greenish shale. Beyond this cliff, the measures are turned up in a synclinal form, and dip N. 80° W. $< 40°$, the lower strata coming up in succession to the northward; and it seems probable that this dip continues up to or beyond the head of the pond to a spot called the Red Ground which may be supposed to represent lower measures corresponding with the variegated slates.

Another basin or trough of the lower portions of the upper formation spreads over a considerable area of the peninsula on the eastern shores of Placentia Bay, the connection of which with the older series has already been described. The lowest members observed here were some red and green strata, holding numerous yellow-weathering calcareous nodules, with bright red and green slates. These are overlaid by a mass of limestone, in which the red colour still prevails, cresting the higher elevations inside the sea-cliffs near Distress Cove. The limestone is in very massive beds, sometimes upwards of 3 feet thick, and is in some parts very silicious. Obscure fossils, all fragmentary, abound in these limestones, although it is doubtful if any have been procured sufficiently well defined for identification. The total thickness of the limestone at Distress is probably between 150 and 200 feet; it dips down at a gentle angle to the eastward at its outcrop near the sea, but reappears again about 2 miles inland with an opposite dip, indicating a narrow trough, the interval being filled up by red and green slates. A dyke of greenstone, about 3 yards wide, was observed to cut through the formation, following the course of the Distress River, the bearing of which is N. 80° W. The overlying red slate or shale is displayed over a much greater extent of country than the limestone, the latter generally being concealed below a great accumulation of broken débris of the superior rock, which from its fissile nature is easily broken and distributed. The slates were seen to cap the higher country north of Distress as far as the valley of Angle's Brook, where the older formation comes through, and again from the north side of Angle's Brook as far as Gooseberry Cove, generally in nearly a horizontal position, or dipping at a very low angle in various directions, but chiefly to the north-west. Near Patrick's Cove on a high elevation the dip is W.N.W. $<$ 12°. At this part the colour of the rock is chiefly a bright red, spotted or patched with green, and is of harder quality than usual, splitting into thin and regular slaty slabs of less than an eighth of an inch thick, in the direction of the cleavage, which runs nearly at right angles to the stratification N. 10° E., S. 10° W., underlying westerly 58°.

The formation was again recognised at Come-by-Chance Inlet, where it comes against the older series, between 1 and 2 miles north of Come-by-Chance Head; but here the immediate junction

is intercepted by an intrusion of trap disturbing both formations, and the upper rocks are tilted all the way up the inlet at a very high angle, averaging < 62°, and pointing more or less to south-east. The lowest beds consist chiefly of grey or greenish impure limestone from 4 inches to a foot thick, alternating with green shale, very much corrugated towards the outcrop, and intersected by veins of white or pinkish calc spar. In consequence of the frequent interposition of trap at this part occasioning great confusion, the exact superposition of the strata is very difficult to unravel; but the next beds, apparently ascending, are a set of very red and partially green nodular limestones, in beds from 3 to 6 inches thick, the nodules varying from 1 to 6 inches in diameter, associated with bright red shales. Following the coast northwards of the nodular limestone, after passing an interval chiefly occupied by eruptive greenstone, with some hard altered sandstone (which may be of the older formation), showing a northerly dip, a cliff of nodular limestone of red and green colour is met with dipping S. 50° E. < 62°, on the surfaces of which many organic remains are distributed, usually however very obscure.* The latter beds strike along the shore to the northward, outcropping occasionally on the western bank of the river, striking towards the eastern slopes of Powder-horn Hill. The variegated rocks of Come-by-Chance Inlet are also exposed less perfectly here and there on the east side, with an opposite dip; but at one place, about half a mile above the bar, a cliff of a loose conglomerate protrudes through the otherwise flat left bank, the age of which is very uncertain. The shores of Trinity Bay I was unable to examine; but according to Professor Jukes † the variegated slates may be seen at the head of Bay of Bulls' Arm, resting on the Signal Hill sandstones. Whether the formation extends unbroken across the isthmus, or is interrupted by other rocks constituting the high dividing ridge, was not ascertained. Another trough of the same formation, in which the variegated slates make a very conspicuous figure, is ably described by Professor Jukes, as extending from Heart's Desire to Tickle Harbour, at the extreme head of Trinity Bay.‡

Red and grey limestones with obscure fossils were seen for the last time proceeding westerly on the east side of North Harbour,

* *Archeocyathus* ? in great abundance. † See Jukes's 'Geology,' p. 90.

‡ Ibid., p. 73.

in a mass about 20 feet thick, underlaid and overlaid by thin greenish bands of impure limestone and green shale dipping north-west at a high angle. On the west side of the harbour the rocks are much disturbed, and the cliffs exhibit numerous intrusions and dislocations. The strata west of the western head of North Harbour chiefly consist of pale yellowish steatitic or talcoid slate, in some parts passing into impure serpentine, which on the east side of the exposure were found to dip N. 60° W. < 62°. These slates everywhere present a shrivelled or corrugated surface, are soft and greasy to the touch, and are generally more or less spangled over by minute green spots of a mineral supposed to be chrome. White quartz veins run in all directions through these slates, but prevail in the direction of the strike of the bedding. In some of these veins some small specks of yellow copper pyrites were detected. Iron pyrites, mostly in minute cubes, is abundant both in the beds and in the veins. Portions of these slates seem capable of being utilised as hone-stones, and will probably be found a good material for setting the finer sorts of edged tools. Advancing across the measures on Sound Island westerly, the dip continues nearly in the same direction, but the rate somewhat increases, becoming nearly vertical, until finally, at Maggotty Cove, at the north extreme of the island, it butts up against a mass of granite, and is no more seen. It would require much more extensive and careful investigation than my time or means could afford to bestow upon one locality, to work out all the complicated details of stratification at this part with such accuracy as to determine the exact horizon to which the Sound Island slates may be attributed; yet, taking their position with regard to the limestone as a guide, together with the mineral and lithological characters presented, it seems probable that they may prove to be of the age of the Quebec group, in one or other of its subdivisions, and it may be remarked that a parallel instance of dislocation was described in last year's Report upon the Cape St. John peninsula, where the rocks of that group were found to be cut off by an intrusive mass of syenite succeeded by gneiss.

The sketch here given of the stratigraphical arrangement was deemed necessary, not only on account of the geological interest involved, but also to illustrate the distribution and position of formations which may be found hereafter to be sources of great

mineral importance. The resemblance the formation I have for the present designated the Intermediate System of Avalon, bears generally to the description given of the gold-bearing rocks of Nova Scotia, is too striking and marked to be overlooked, and the inference is that on further inquiry it will prove to be of the same horizon. So far as I know, as yet, the age of the Nova Scotia gold-bearing rocks has never been satisfactorily determined; although it has for some time past been treated of as Lower Silurian. Here, on the other hand, I think I have made it plain that the Lower Silurian rocks are unconformably related to the rocks supposed to be the equivalents of those of Nova Scotia, and should future investigation discover similar relations on that part of the continent, the age of the auriferous rocks will be finally determined. Beds holding *Paradoxides* are known to repose upon an older series, supposed to be Cambrian, near St. John, New Brunswick, and it seems to me highly probable that the extension of the latter into the neighbouring provinces will prove to be the great gold-bearing series of Nova Scotia.

I have already in my possession a considerable collection of quartz from veins at different localities, which as soon as an opportunity offers I intend placing in the hands of Dr. Sterry Hunt for analysis; and being desirous of proving as many samples as possible of such veins, I imagine it would be prudent to extend the collection early in the spring.

Economic Materials.

Gold.

I have already stated that there is reason to presume that the rocks so largely distributed over the peninsula of Avalon are likely to prove to be the equivalents of the auriferous strata of Nova Scotia, and that in order to prove the presence or otherwise of the precious metal, I have done my utmost to procure specimens from as many quartz veins as possible, to be submitted to chemical analysis. It frequently occurs that the metal is disseminated through the rock in such exceedingly minute particles as to be quite invisible even with the aid of a powerful lens, and instances have been known of quartz of that description giving a yield of

an ounce of gold to a ton of rock. While examining the coast of Conception Bay a small specimen of quartz, with minute specks of *what appeared* to be gold, was shown me by Mr. Fitzgerald, who was engaged in sinking a shaft in a copper lode near Holyrood, and I was informed by the same person that some quartz from the same locality, which had been sent to New York to be assayed, had been represented to have given a yield equal to nearly 2 ounces to the ton. These statements must of course be taken guardedly, but are nevertheless worthy of attention, and should act as an incentive to further inquiry.

While discussing the distribution of gold, it ought to be distinctly understood that it does not follow as a matter of course that the metal should only be found in any one particular formation; but that the *condition* rather than the *age* of the rocks should be the guide to be followed. These conditions obtain in a high degree both in Nova Scotia and in this island; here, in the peninsula of Avalon, most especially in the intermediate rocks; while the Lower Silurian strata are comparatively unaltered or undisturbed.

Sir Roderick Murchison says in his last edition of 'Siluria' (page 448):—"Let us first reflect upon the general fact that, whilst all the stratified formations are composed either of crystalline or Palæozoic rocks, or of secondary or tertiary deposits, gold has never been found in any appreciable quantity in either of the two last-mentioned classes of strata, *when they are in their natural state*, i. e. when they have not been penetrated by igneous rocks, or metamorphosed and impregnated with mineral veins. The vast areas, therefore, which are covered by all such younger unaltered formations are excluded from the general auriferous area, and every one who lives in tracts, the subsoil of which consists of such unaltered rocks, may at once be assured that he can never find gold in them."

Now, although the Lower Silurian portions displayed in this part of Newfoundland are, as already mentioned, comparatively undisturbed (for example, as in the Bell Isle group of islands), they are displayed at other parts of the province under very different circumstances, and will in all probability be found in some parts of their distribution to be auriferous as well as the inferior formations. Indeed, traces of gold have already been found in quartz veins

cutting Silurian rocks, as I took care to show in a pamphlet I published in London nearly two years ago, in the 'Journal of the Society of Arts.' The curious combination of metalliferous substances in that part of the Lower Silurian system known as the Quebec group, and the mineral condition that that part of the formation usually assumes in this island, seems to indicate the possibility that gold will hereafter be enumerated amongst its metalliferous products. Among my collection of quartz, I have some from veins near the serpentines of the Cape St. John peninsula, which may, when analysed, throw some light upon the subject. There are numerous strong well-defined quartz veins in the immediate neighbourhood of Tilt Cove, already so celebrated for its vast deposits of copper and magnetic iron. A thorough investigation would in all probability be found in some parts to add the presence of the precious metals to the long list of other interesting minerals of the vicinity, known at the present time.

Copper.

The ores of copper are of frequent occurrence, often in the form of grey sulphurets, in the veins or dislocations of the intermediate series. Many small openings have been made at various parts of the formation from time to time, with the view of mining, where such indications present themselves; but I am not aware of a single instance where the enterprise has proved remunerative. These experiments, however, have only been conducted on the very smallest scale, and it may be that were a more vigorous and skilful system followed, in some cases the ore might be worked with profit. I have already shown that the rocks have many of the characteristics of the Huronian system in Canada, in which the well-known Bruce and Wellington mines of Lake Huron are situated, and which, in consequence of the frequency of its cupriferous veins, has been termed the lower copper-bearing series of Canada. It seems therefore highly probable that, by judicious selection of localities, and energetic application of skilled labour, copper may be mined in some parts of the region with advantage. As I have often remarked before, however, I still incline to the belief that the great copper deposits will be chiefly found in rocks of the age of the Quebec group, and especially in close association

with the serpentines. It will be gathered from the preceding pages that, according to my present views, the formations in the south-east end of the island, are all lower in geological horizon than the rocks of the Quebec group, unless we except a limited portion in Placentia Bay, of which Sound Island is a part, as of that age; and I have further shown that the lower or intermediate series being repeated to the westward, and lying on the whole moderately flat, probably extends to a great distance in that direction from Piper's Hole River. These views are in some measure corroborated by the observations made many years ago by the enterprising traveller, W. E. Cormack, who, in describing the mineral character of the country, nearly due north from Bay D'Espoir, and near the very centre of the island, says:—"The mineralogical appearances here were altogether so singular that I resolved to stop a day or two to examine them. All the highest parts of the ridge were formed of this metallic rock, and were extremely sterile. The other rocks were *noble* serpentine, varying in colour from black, green to yellow, and from translucent to semi-transparent, in strata nearly a yard wide, *steatite* or *soapstone, verde antique, diallage,* and the other magnesian rocks. Sterile red earthy patches, entirely destitute of vegetation, were here and there on and adjacent to the ridge, and in these lay heaps of loose fragments of asbestos, rock-wood, rock-cork, rock-leather, rock-horn, and stones light in the hand, resembling burnt clay, *cum multis aliis;* the whole having the appearance of heaps of rubbish from a pottery, but evidently detached from adjoining strata and veins."

Here then are all the conditions of the Lauzon division of the Quebec group, the acknowledged great metalliferous zone of North America, and probably its nearest outcrop going from east to west, or it would hardly have escaped the eye of such a vigilant inquirer as Mr. Cormack. It would be highly desirable that the survey should be extended through this region, by the way of the Bay D'Espoir, thence across the island to the Bay of Exploits, by which means, in addition to what has already been ascertained, a good general knowledge of the character of the whole island will be accomplished.

The following are some of the instances of the presence of copper ore in Conception Bay:—At Holyrood South Gut a dislocation or fault runs S. 35° W., N. 35° E., intersecting porphyry and

quartzite with much epidote and chlorite, nearly along the course of the brook, in which the grey sulphuret of copper was found disseminated, and the rock stained with green carbonate of copper. There did not appear to me to be any well-defined vein filling up this dislocation, although masses of quartz are contained in it; and a specimen was shown me by Mr. Fitzgerald which was moderately well sprinkled over by the yellow sulphuret of copper. A shaft had been sunk upon this dislocation, and a party was employed at the time of my visit in continuing the excavation; but the prospects of the mine did not appear to me very encouraging, and I have not learnt that there has been any improvement since.

At Crow's Gulch, near English Cove, on the west side of Collier's Bay, an indication something resembling the last mentioned was visited, which had several years ago been partially opened but abandoned. The dislocation in this case intersects the porphyry of the coast, running N. 67° W., S. 67° E. Some beautiful specimens of grey and variegated copper ore were observed in the crack; but here, as in the former place, there did not appear to be any well-defined vein.

Another place where the presence of copper ore had induced an attempt at mining is at Turk's Gut, also upon the west shore of Collier's Bay. Here the lode is tolerably well defined, cutting amygdaloid in a course S. 45° E., N. 45° W. The amygdaloid here is intersected by numerous veins of calc spar, which are often thickly speckled with copper, chiefly of the grey or variegated ores. A drift had been driven upon the main vein or lode at a height of 113 feet above the sea-level, for about 30 yards, and a shaft sunk about 20 fathoms deep, but the results do not appear to have been satisfactory.

On the north side of the north-east arm of Placentia Bay, a vein of white quartz from 4 to 5 feet wide displays the grey sulphuret in considerable profusion sprinkled irregularly through the mass; and the cracks in the rock on either side are occasionally stained with green carbonate. The vein cuts through porphyry running N. 60° W., S. 60° E., underlying north-easterly, and is traceable for about a quarter of a mile on that course from the shore. This vein had at one time been drifted on for some 70 or 80 feet at one place, and a shaft sunk upon it for 14 or 15 feet

at another; but being without profitable results was abandoned. Although abandoned, the little excavation hitherto made can hardly be said to have proved the vein; and it is not improbable that in some parts of its course, especially where intersecting veins, of which there are several, come in contact, a profitable amount of ore might be brought to the surface.

There are several places in both Placentia and St. Mary's Bays, where the ores of copper are displayed in the intersecting veins; but although such indications are numerous and the ore of a rich quality, it does not usually appear to be persistent, but rather to occur in isolated masses, rarely in such abundance as to justify the large outlay requisite for the development of a mine. The presence of the ore, however, is so general in the veins of the intermediate system as to constitute a characteristic; and it may happen, as was said before, that when the country becomes better known and opened up, mines may spring into existence of as much importance as the Bruce and Wellington in the sister province.

Lead.

It has already been remarked that calcareous veins are of frequent occurrence throughout the distribution of the intermediate system, and that many of these are charged with galena, together with other ores. The most notable instance of this sort is the La Manche mine in Placentia Bay, but there are many others at various localities in Placentia, St. Mary's, and Conception Bays where the indications are such as to warrant a fair trial.

A short account of the La Manche mine was given in my Report for 1866. During the past season more particulars regarding that locality have been ascertained, which will be illustrated upon the plan I am now constructing. The statistics of the mine are nearly as follows:—

The works were first commenced in 1857 by Messrs. Ripley and Co., under whose name and title the mine was carried on for the first few years of its existence, when it passed into other hands, who assumed the title of the Placentia Bay Lead Company; and finally it was once more transferred in 1863 to a third company, termed the La Manche Mining Company.

The combined operations of the three several companies have produced the results here given, nearly up to the present time.

Length of adit level, commencing at the sea-shore, a little over high-water mark, 1555 feet. Six main shafts have been sunk upon this adit, and a considerable amount of stopeing has been done between

No. 1	shaft called	Cooper's	75	feet to water-level.
No. 2	„	Taylor's	110	„ „
No. 3	„	McConachie's	95	„ „ by
			66	„ below „
No. 4	„	Kelly's	114	„ „
No. 5	„	Cohu's	120	„ „
No. 6	„	Hunt's	110	„ „

According to a calculation made upon the spot, somewhere about 537 cubic fathoms had been excavated by Messrs. Ripley and Co., yielding 1800 tons of ore, or at the average rate of nearly 3·4 tons to the cubic fathom. The Placentia Bay Company excavated about 379 fathoms, which produced 450 tons of ore, or at an average of 1·18 per fathom; while the present company, between January and June in 1867, seem only to have made an average of 1580 lbs. to the cubic fathom, or not greatly exceeding half a ton. The total amount raised seems to be altogether about 2350 tons of ore, but the works have been lately carried on very languidly, and only to the extent of a sufficiency to pay working expenses. About 25 tons of ore have been taken from trial pits outside the works, in addition to the above. At the time of my visit, there were only 25 men employed about the works. In making the above calculation the vein was taken all over at 3 feet wide, which is about the average, but it frequently is much thicker, and occasionally is upwards of 7 feet. The course of the lode, as traced along the surface from the shore, is:—

1st.	N. 54° E.	23·00 chains.	
2nd.	N. 65° E.	21·50 „	to the brook which it crosses.
3rd.	Ditto	10·00 „	
4th.	N. 82° E.	20·00	

The six principal shafts are sunk upon the first bearing, where the vein maintains, on the whole, a tolerably straight course. The vein is intersected by a cross course near the fourth shaft, running N. 19 E., where the ore was found in considerable abundance. Some rich bunches of ore were likewise found in pockets, where the vein shows itself on the right bank of the stream in the second

bearing; and on the third bearing several trial shafts were sunk, from each of which more or less ore was abstracted, the general character of the vein being but little changed, except in the fact that it decreased in width and was never over 2 feet in thickness. From the end of the third bearing the vein is concealed by marshy and bushy ground, but I found by costeening at the end of the fourth a calcareous vein, which was supposed to represent the lode, of only 6 inches in thickness. Whether the vein widens again in its course to the eastward, or whether it wedges out altogether near this part, can only be proved by close inspection of the ground and a system of costeening at intervals along the surface in the direction of its course, which, judging from the tendency apparent in all the courses so far as traced, would be nearly due east.

Although no great metalliferous indications were observed in the calcareous veins which intersect the strata at Isle Bourdeaux and Come-by-Chance Head, it is not improbable that some of these, upon closer inspection and trial, might prove of importance, as the conditions are similar to those of La Manche, and the rocks are of the same formation although higher in superposition. I was informed that some calcareous veins were known to intersect Long Island, near Harbour Buffet, which contain galena, but these I had no opportunity of examining.

On the eastern shore of St. Mary's Bay several indications of the presence of lead were seen, sometimes associated with specks of copper, iron pyrites, and blende. One of these is situated about a mile and a half from the village of St. Mary's, on the south-eastern side of the harbour. The rock is chiefly thin-bedded quartzite, divided by layers of a greenish arenaceous shale or slate dipping S. 60° E. $<$ 38, and the largest or main vein, which intersects the strata, varies in thickness from 3 to 8 inches; it is of white quartz, spotted through with small cubes of galena, associated with blende and specks of copper pyrites. The run of the main vein bears S. 76° E., N. 76° W., the attitude vertical, but the strata near this are reticulated by numerous small quartz veins, in which iron pyrites are thickly disseminated. The low cliffs and ledges along the shore here are much stained of a rusty brown colour, and a ferruginous deposit may occasionally be seen along the banks, derived from the decomposition of iron pyrites.

Some strong quartz veins also were seen to intersect the cliffs near the extreme point of the peninsula dividing St. Mary's Harbour from Mal Bay. The rock here is quartzite and slate, dipping from S. 45° E. < 45° to S. 65° E. < 60°. The largest veins, one of which was found to be 6 feet thick, run nearly due east and west. Some thin calcareous seams, and occasionally patches of calc spar, occur here also irregularly. An opening had been made upon this large vein some time since, and near the top of the cliff, which is very precipitous and about 149 feet high, the remains of a rude forge were discovered, which it was supposed had been erected for the purpose of smelting; but the only substance perceptible that had been submitted to that process appeared to me to be chlorite. Iron pyrites there are in abundance both in the beds and in the veins, and some small specks of yellow copper were now and then detected, but I did not perceive any metalliferous indications of great importance, whatever the result of more extensive trial might produce.

A little over half a mile from the Town Point, at the entrance of Placentia Bay, on the south-east side of the north-east arm, some small calcareous veins intersect the cliffs, which hold galena. Where this was chiefly observed, the rock, which is a diorite, appears to have been affected by a double dislocation, the one intersecting the other so as to cut out the upper part of the cliff in the form of a wedge. In the cracks thus produced the lead runs sometimes in the solid form of prill ore, from 1 to 3 inches thick, and also in disseminated crystals through the calcareous matrix. The general bearing of the lode appears to be about N. 70° W., S. 70° E.

Another vein of similar character, about 3 or 8 inches thick, occurs nearly opposite the town, a little way inside of the entrance to the south-east arm and running N. 51° E., S. 51° W. The rock here is in hard, green, very compact cherty beds, varying in thickness from 1 inch to a foot, which by the vein dip S. 40° E. < 28°, and show a cleavage or jointed structure nearly at right angles to the dip, underlying at a very high angle easterly. Should the course of this vein continue as indicated on the shore, it would intersect the vein seen on the north-east arm at about 60 chains, and should that prove to be the case, the intersection would be well worthy of being fairly tested for the metal.

From the numerous indications presented, at different parts of the province and in different geological positions, of the presence of lead ore, we may fairly infer that it will, in process of time, become an important material among the economic resources of the country.

Manganese.

The only form in which I have seen this material in the province is as wad or bog ore, and never hitherto in sufficient abundance to be economically valuable, although such may be the case at parts unknown. The presence of this mineral was observed on several occasions near the junction of the unconformable Lower Silurian with the older rocks, especially where a subsequent disturbance had dislocated or fractured the strata at the junction, such as at Topsail Head or on the shores of Placentia Bay. It was generally seen in a tufaceous state, scattered over the ground in these localities, or mixed up with the crushed materials in small fragments in the neighbourhood of the fault. The pebbles of the brooks on the peninsula between St. Mary's and Placentia Bays are frequently, or it may be said generally, encrusted by a thin film of this substance, and the low marshy banks often display black earthy spots, probably deriving the colour from the same. Bog iron seems to be usually associated with the manganese, small tufaceous masses of which were seen on a few occasions while crossing the same peninsula. Manganese is chiefly used for bleaching purposes, and is in great demand in Great Britain. It is also used as a dye, and in the colouring of glass and earthenware.

Building Stones.

Granite.—The granites and syenites of the Laurentian series are in many parts of the handsomest and most durable description, and their distribution throughout the island cannot fail to prove of the highest advantage hereafter should any great public works, such as railways or canals, be carried on. In my Report for 1866, p. 97, the granites of La Poile and Rose Blanche are mentioned as affording this material to a boundless extent and of the most beautiful quality. Following the prevailing strike of the formations generally, the granites, which form the remarkable tower-

like peaks and the elevated ridges between the Grand and Red Indian Ponds, are probably an extension of the granites of La Poile and Rose Blanche, and must necessarily intersect the country about the head waters of the Exploits, where, in the event of a railway being constructed across the island, much if not most of the bridging would be required, and the material of the finest description producible on the spot. A beautiful description of granite was also observed at Black River, at the head of Placentia Bay, and this also appears to extend in the strike of the mountain chain towards Clode Sound in Bonavista Bay.

Rocks of this character also abound in Conception Bay, and fine varieties of granite, syenite or gneiss, may be quarried in unlimited extent at many places between Manuel's Brook and Holyrood, as also between Salmon Cove and Cat's Cove.

Sandstone.—The grey or greenish variety of the Signal Hill sandstone is used, to a considerable extent, for building purposes near St. John's. The handsome building, now in progress, of St. Patrick's Church, at Riverhead, is an example. The sandstones of Kelly's Island are already known, and are mentioned in the Report for 1866, together with sandstones fit for building purposes observed at other parts of the island.*

Roofing Slates.

Slates of excellent quality occur in division *c* of the intermediate system, and are known and have been partially worked at different parts of the island. The formation, being the supposed equivalent of the Cambrian system of Great Britain, in which the celebrated slates of Carnarvonshire are situated, may be regarded as the horizon in particular where that most useful material will be found. It ought to be observed, however, that the economic value of a slate very much depends upon the direction of the cleavage. When the cleavage coincides with the bedding, which is often the case, the rock is comparatively worthless as a roofing slate, although sometimes useful for flagging; whereas, when the cleavage is oblique or at right angles to the bedding, it frequently yields the best of material, splitting into smooth and regular plates,

* See Report 1866, p. 97.

often less than the eighth of an inch in thickness, on which the planes of stratification may be seen by palpable lines of discoloration. By careful and proper selection of locality, I have very little doubt that good slates might be worked to advantage in the neighbourhood of St. John's and at many parts on the western side of Conception Bay. The ridge which terminates at Brigus Head seems to be capable of yielding a good slate at several parts within its range; and on that ridge, on the sea-shore, a slate quarry was opened several years ago, I believe, by Mr. C. F. Bennett of this place. The quarry has, however, been long abandoned, not, I imagine, from the deficiency of material, but from want of a remunerative local demand.

Limestone.

It has already been stated that the beds of the intermediate system are rarely found to be calcareous, although calcareous veins frequently intersect them. It follows as a matter of course that throughout the great area which the formation occupies, material sufficiently pure for the purpose of burning into lime need hardly be expected; but as the system which follows contains bands of limestone at its base, the rock may frequently be found available for economic purposes near the junction. Such is the case at Topsail Head; at the points near Harbour Main; at Brigus South Head; and probably some of the points farther north in Conception Bay; at and near Cape Dog, in St. Mary's Bay; at D'Espoir; at Come-by-Chance; at North Harbour, and possibly at Red and Fox Islands in Placentia Bay. In all these parts (except the latter two, which were not visited, and which consequently are uncertain) limestone abounds; but much of it being very silicious, it would require to be carefully selected for the purpose of burning.

The limestones here mentioned are frequently capable of taking a high polish and affording handsome marble, the colours which prevail being red, green, black, and drab, often all blended together, and giving a beautifully variegated surface. A specimen from Topsail was sent to the Paris Exhibition in 1867.

Sulphate of Barytes, or Heavy Spar.

This mineral was very frequently found in veins intersecting the intermediate system. It occurs at Topsail Head, where the

veins however appeared to be small. The largest vein that was observed was on the coast of Placentia Bay, near Cross Point, not far from Distress, which is about 3 feet wide; its course lying about north-west and south-east, and attitude nearly vertical. At La Manche mine and neighbourhood, this substance is frequently found associated with the calcareous veins. The usual colour is a dull white, but it is often tinged with pink, and can easily be distinguished from calc spar and other minerals by its great specific gravity. For its economic value or importance, see pp. 458 and 770 of the 'Geology of Canada,' 1863.

Whetstone or Hones.

The talcoid slates of Sound Island appear in some parts of their distribution to contain a material well adapted for such purposes. I have a specimen, among my collection, of this description, but as yet have been unable to test its value by actual experiment. Honestones of superior quality are obtained in some parts of Eastern Canada from the slates near the serpentines, and the rocks of Sound Island are supposed to be of the same horizon. Should this stone prove equal in quality to that in Canada, it may be found in Sound Island *in inexhaustible quantity.*

I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

To His Excellency
The Governor of Newfoundland.

APPENDIX.

SECTION OF THE CARBONIFEROUS MEASURES OF THE WESTERN COAST OF NEWFOUNDLAND.

I HAVE hitherto deferred the publication of this section, in hopes of having an opportunity of further examining the coal regions, and especially of following the outcrops of the workable seams, which may shortly become of vast commercial importance. The unfortunate accident I met with in 1866 rendered me incapable

of walking into the interior at that time; but previous to that occurrence, I had made a careful examination of the coast north of Cape Ray, and surveyed the Codroy Valley, and also some of the country on the south side of St. George's Bay. These surveys having been duly mapped upon an intelligible scale, and the geological features recorded thereon, it immediately suggested itself to me, that if there were any workable seams at all, they must be found in the neighbourhood of the great fault I described as running from Trainvain Brook diagonally across the island to White Bay,* and that if so, a considerable segment of the trough they lay in would be cut off by the upthrow on the south-east side. Taking the position of the seam Mr. Jukes records as having seen as a starting-point, I traced its probable outcrop upon the map, guided by the features I had ascertained upon the coast and the valley of the Codroy. The result has been highly satisfactory; as I am assured by Professor Bell, who has since visited the spot, that were he to map the outcrop that he had followed on the ground, he could hardly have come nearer the reality. The summing up of all the evidence gathered in the St. George's Bay region comes to this:—An anticlinal affects the coalfield, running from Cape Anguille towards the head of St. George's Bay, and divides it into two troughs; the trough on the south-east side of the anticlinal, in which the workable coal is situated, extending towards the base of the Laurentian mountains; whilst the trough on the north-west side, which probably contains considerable additional higher measures, and may have additional coal seams also, is under the sea.

The lower measures, as may be seen by the coast section, are barren of workable seams; resembling the lower measures of Cape Breton in that respect, of which they are undoubtedly the equivalents.

To show the enormous importance of the existence of even one solitary seam of workable coal, I have made the following calculation of what might be expected within the area supposed to be underlaid by the one shown on my map. Taking the area of the plane of the seam at 38·4 square miles, and its thickness at 3 feet, there would be 54,720,000 chaldrons of coal, or 1,425,000 chaldrons per square mile. It is true a great part of this would

* Chap. v., Report 1866, p. 90.

be inaccessible, on account of its great depth, if the strata are turned up at a sharp angle to the horizon; but on the other hand, as seems very probable, it may be found that a set of minor dislocations occur, running more or less parallel with the great one, and upthrowing the strata in the same direction; and, if so, the same seam would in each case be repeated, and so more and more of it would be brought towards the surface, and within workable depth.

In addition to the coal itself, beneath each workable seam, there is usually a bed, sometimes of great thickness, which is well adapted for fireclay; and kidney ironstone often occurs in parallel strata. It will be seen by reference to my Report of 1867, that magnetic iron may also be found in close proximity to the coal-field of St. George's Bay.

The coast section between Cape Anguille and Codroy Island consists of masses of sandstone, coarse conglomerate, and thin beds of limestone with black shale. The thickness of this mass of strata was not accurately ascertained, in consequence of the frequency of the contortions rendering it very difficult to determine. It is very considerable, however, and was supposed to represent the formation known in England as the Millstone Grit, or lowest portion of the Carboniferous series. The rocks which succeed these measures are of great economic importance, as the zone in which great masses of gypsum occur. They are also exhibited in a very disturbed and corrugated state, the corrugations being most eminently conspicuous near the gypsum. These seem to be arranged nearly in the following order:—

Ascending.	Feet.
1. Red, green, and jet black carbonaceous shales and marls, with great masses of gypsum *	140
2. Thin-bedded impure limestone and calcareous shales, which occasionally contain fossil shells, resembling those found in 1865 in the coal strata at Port-a-Port, and numerous remains of plants †	110
3. Grey calcareous shale, with thin beds of impure limestone ..	132
4. Greyish micaceous, and sometimes calcareous sandstone, in beds from 6 inches to a foot thick, in which obscure comminuted and carbonised remains of plants are numerous ..	300
	682

* For further description, see Report 1866, p. 87.

† See Note, Report 1865, p. 68.

Between Stormy Point and the mouth of the Great Codroy River the rock is concealed beneath a thick deposit of superficial drift; but there is a fine display of the measures on the coast between the Great and Little Codroy Rivers, the strata of which are as follows, in the ascending order:—

Dip S. 42° W. < 23°.

	Feet.	In.
1. Red and green arenaceous shale, with thin bands of variegated red and green sandstones, from 2 to 6 inches thick	5	0
2. Concealed strata, probably similar to the above	10	0
3. A bed of fine conglomerate, pebbles chiefly of white quartz, and some of gneiss and red feldspathic rock, in a matrix of sand with much mica in small scales	4	0
4. Green arenaceous shale	4	0
5. Fine conglomerate, not well seen	5	0
6. Strata concealed	35	0
7. Brown and greenish shaly sandstone, the upper part a coarse shale of a greenish colour and very micaceous, slightly corrugated	11	0
8. Red and green shale	57	0
9. A band of fine conglomerate, of similar quality to the last	2	0
10. Green shale, with large concretions of sandstone, of spherical form, from 6 inches to a foot in diameter ..	3	0
11. Green shale, with two thin beds of conglomerate at the top, each about a foot thick	9	0
12. Conglomerate beds, interstratified with greenish arenaceous shale and sandstone, beds of conglomerate and sandstone from 6 inches to a foot thick	43	0
13. Red shale	7	0
14. Concealed strata .. .. say	6	0
15. A strong bed of hard grey sandstone, with some scattered pebbles of quartz	1	6
16. Green arenaceous shale, with a bed of shaly and very micaceous sandstone at the top, which contains obscure impressions of carbonised plants and patches of coal	16	0
17. Green arenaceous shale, coarse in texture, passing into beds of flaggy sandstone, with bands of green sandstone from 4 to 6 inches thick	26	0
18. A bed of rather coarse conglomerate, the matrix of coarse sand, loose and shaly	5	0
19. Green coarse-grained arenaceous shale, with conglomerate beds from 1 to 2 feet thick	9	0
20. Thin-bedded flaggy sandstone	8	0
21. No rock exposed, a sand beach .. .. say	17	0
Carried forward	283	6

		Feet.	In.
	Brought forward	283	6
22.	A bed of red shaly or flaggy sandstone	1	0
23.	Alternations of green and red marly shale, only partially exposed	44	0
24.	Beds of conglomerate in a green arenaceous matrix, the conglomerate beds from 1 to 3 feet thick	6	0
25.	Green and brownish-grey sandstones; some surfaces displaying a very distinct ripple mark; some beds very thin and shaly, others from 2 to 6 inches thick	20	0
26.	Conglomerate, in a matrix of arenaceous shale, with some hard brownish-grey beds of sandstone from 8 inches to a foot thick	21	0
27.	Brown sandstone, parted by dark grey arenaceous shale, with some obscure carbonised impressions. Beds from 6 to 18 inches thick, last irregular. All these strata are very micaceous	8	0
28.	A bed of dark brown sandstone, partially conglomerate, the upper part of which is black from the presence of a mass of carbonised and comminuted plants and colouring matter	2	0
29.	Brown and green sandstones, in beds from 6 to 18 inches thick	10	0
30.	Red marly shale and thin irregular layers of red sandstone	4	0
31.	Red marls with thin layers of red or greenish sandstone	38	0
32.	Brownish-grey sandstone, reddish at the base, much iron-stained, numerous impressions of plants, with nests and patches of coal	3	0
33.	A bed of brown sandstone	2	6
34.	Green and reddish marls, with some thin beds of sandstone, generally about 6 inches thick	11	C
35.	A bed of black carbonaceous shale crowded with carbonised impressions and patches of coal	1	0
36.	Green shale	2	0
37.	Mottled red and green coarse micaceous sandstone ..	2	0
38.	Red marls	32	0
39.	Brown ferruginous sandstone	2	6
40.	Black carbonaceous shale	0	6
41.	Green arenaceous shale, with concretions of sandstone generally flattened on lower surfaces, and sometimes on the upper ones; varying in thickness from 6 inches to a foot. Rough irregular surfaces on the sandstone, crossed by a cleavage at right angles to the bedding	11	0
42.	Green and reddish shale, showing minute corrugations	18	0
43.	Brown and reddish shale, with sandstone in thin beds ..	18	0
44.	Green and reddish sandstone and arenaceous shale ..	16	0
45.	Mostly concealed up to French Pilots' Landing, say ..	10	0
	Carried forward	567	0

From the entrance of Codroy River to the brook at French Pilots' Landing. Dip S. 77° W. < 25°, at the latter place:—

	Feet.	Feet.
Brought forward	..	567
46. Green micaceous sandstone in beds from an inch to a foot thick, divided by green marls, numerous obscure impressions of plants	5	
47. Red marls and thin-bedded sandstones	57	
48. Fine conglomerate, and green and brown ferruginous sandstone and shale	20	
49. Greenish and drab-coloured arenaceous shale, with beds of brown sandstone	60	
50. Red sandstone and red marl alternating; the sandstone beds irregular in thickness, thinning and wedging out with layers of elementary bedding	35	
51. Green sandstone and green marly shale, as before ..	40	
52. Beds of green and red shale, with some concretionary beds of sandstone and conglomerate at the top; the measures striking with the coast	30	
53. Red and blackish shale	15	
54. Green shale with conglomerate on the top in a crumbling shaly bed of 2 feet thick	25	
	—	287

Up to the point where Stormy Point bears N. 24° W.:—

	Feet.	Feet.
55. Drab-coloured, brown and green, coarse-grained micaceous sandstone	40	
56. Red marls and reddish and green sandstone in thin beds	25	
	—	65

These last beds appear to be rolled over again near the brook. South from A. the succession is as follows:—

	Feet.	Feet.
57. Grey sandstones in rather heavy beds—one about 6 feet thick	30	
58. Red marls	20	
59. Brownish ferruginous sandstone, in strong irregular beds, cut up by elementary layers, and generally soft or incoherent	35	
60. Red marls	25	
61. Strong beds of grey or brownish sandstone, from 1 to 2 feet thick, which towards the water's edge are occasionally worn into pillar-like forms	35	
62. Red marls and sandstone in thin beds, not often over 6 inches thick	60	
Carried forward	205	919

	Feet.	Feet.
Brought forward	205	919
63. Grey sandstones similar to No. 61	25	
64. Red marls	20	
65. Brown ferruginous sandstone, lower beds heavy, from 1 to 3 feet thick, upper beds thin and flaggy	30	
66. Beds of black argillaceous and carbonaceous shale or clunch, with layers of coarse brown sandstone, containing numerous patches of clay or shale. One bed of clunch about 2 feet thick. Vegetable impressions	15	
67. Brown ferruginous sandstone	30	
68. Red sandstone and marls, the sandstone chiefly in beds from 6 to 18 inches thick	30	
69. Red marls	50	
	—	405

A fault occurs at 69, and the strata are repeated from 61, giving an upthrow of from 200 to 300 feet:—

	Feet.	Feet.
70. Strong beds of brownish sandstone, from 1 to 3 feet thick, parted by red arenaceous shale	30	
71. Brown ferruginous sandstone, upper beds thin and flaggy, with thin partings of black argillaceous shale	25	
72. Red marls, with some bands of black shale, and thin irregular bands of sandstone	10	
73. Alternations of drab or brownish sandstone, and grey or greyish shales, one bed of sandstone 5 feet thick ..	50	
74. Red marls, and thin hard bands of fine-grained pinkish and green sandstone	15	
75. Blackish shale with thin bands of grey sandstone ..	10	
76. Red shales and marls	20	
77. Thin-bedded grey sandstone	10	
78. Red shales and marls	15	
79. A strong band of grey sandstone	7	
80. Red marls	30	
81. Green sandstone, sometimes worn into pillar shapes ..	20	
82. Red marls and drab-coloured and mottled sandstone ..	60	
83. Grey and reddish sandstone	25	
84. Red marls	10	
85. A strong irregular band of greenish or mottled sandstone, wedging in with red shale	7	
86. Red marl and red arenaceous shale	17	
87. A massive bed of grey or greenish sandstone	12	
88. Irregular beds of brownish crumbling sandstone	7	
89. Red marls with thin beds of green or red sandstone ..	30	
90. Grey or greenish sandstone, with some layers of black and reddish argillaceous shale	20	
91. Red and green argillaceous shale	25	
Carried forward	455	1324

		Feet.	Feet.
	Brought forward	455	1324
92.	Brownish and grey sandstone, in thick but irregular layers, fine shaly conglomerate at the base. Beds cut up by layers of elementary deposits	20	
93.	Reddish marls and sandstones, marl predominating. Some blackish or brown shale between the beds of sandstone, which run from 6 inches to 2 feet thick or more. Occasional beds of fine conglomerate among the red and green arenaceous shale, near the base ..	25	
94.	Red marls, with thin-bedded sandstone and fine layers of black argillaceous shale from 6 to 8 inches thick ..	25	
95.	Black and reddish marly beds, the upper part mostly red; the black beds holding regular layers of calcareous nodules, varying in size from that of a pigeon's egg to 6 inches in diameter	50	
96.	Grey coarse-grained sandstone in a succession of strong beds,—one about 7 feet thick, intersected by cleavage at right angles to the bedding, and overlaid by thin flaggy layers. Obscure carbonised remains	25	
97.	Green, blackish, and brown arenaceous shales, with large spherical concretions of sandstone	25	
98.	A band of variegated sandstone, partially conglomerate	7	
99.	Blackish shales, with brown sandstones—mostly black shale about the middle part	60	
100.	Thin-bedded grey sandstone, with red and green shale	35	
101.	Thin-bedded green and reddish flaggy sandstone	15	
102.	Red and brown shales, with some beds of brown sandstone	70	
103.	A considerable portion of coast mostly covered with drift material, where the strata are not exposed, and the thickness not established, probably nothing, No. 104 being a repetition.		
104.	Red marls, with some thin beds of sandstone	40	
105.	Brown, moderately hard, strong beds of sandstone ..	20	
106.	Black argillaceous shale, surmounted by red marls and beds of brownish sandstone	30	
107.	Brown and reddish sandstone, divided by thin layers of black, brown, or reddish argillaceous shale	25	
108.	Strong beds of brown sandstone	15	
109.	Red marls	20	
110.	Irregular beds of brown or dark grey sandstone	15	
111.	Green and red variegated shale	5	
		—	982
	Total thickness between rivers		2306
	Strata between Codroy and Stormy Point		682
			2988

Exclusive of the Cape Anguille strata.

CHAPTER IX.

REPORT FOR 1869.—COPPER LODES OF BONAVISTA BAY—SURVEY OF TERRA NOVA RIVER—MR. JAMES P. HOWLEY APPOINTED ASSISTANT GEOLOGIST—HIS REPORT ON COAST OF TRINITY, PLACENTIA, AND ST. MARY'S BAY, &c.—EXCURSION UP BAY EAST RIVER.

St. John's, Newfoundland,
1st February, 1870.

May it please your Excellency,—

In presenting the following Report of progress made on the geological survey of this province, I beg leave to premise the subject by intimating that in the meantime I am necessarily obliged to confine myself to generalities, or a simple history of the manner in which I have been employed, as there are many matters of reference requiring to be thoroughly investigated and explained before it would be prudent to enter into minute geological detail. The assistance, in particular, to which I refer, is that of the palæontologist and chemist; but there is also the paramount necessity of having a correct geographical map constructed upon a good scale, before it is possible to make the structural arrangement intelligible, even to myself, or to present any part of the country in section. With these ends in view, a very considerable collection of fossils and minerals was sent to Sir William Logan last spring, who has since kindly placed the former in the hands of E. Billings, Esq., palæontologist to the Geological Survey of Canada, the latter being referred to Dr. Sterry Hunt for analysis; and I have now in my possession many more such specimens, ready to be sent to Montreal for the same purposes by the earliest opportunity. A letter recently received from Mr. Billings informs me that my fossil collection has been his study for several months, and that it contains many forms not hitherto known, having many new species and a few new genera

among them, to which he has provisionally given names, and that the whole are seemingly typical of the Primordial Silurian age. This fact is satisfactory, as it goes far to corroborate the correctness of the views I expressed as regards the general structure, in my Report of last year.

Among the minerals referred to Dr. Hunt there are samples of quartz from various parts where the precious metals were suspected to exist, as well as ores of sundry sorts from different localities; but of these I have not heard any particulars as yet, further than that they were now being attended to.

With regard to the construction of a map; the plan I have adopted has been to lay down the coast from the latest and most accurate surveys, on the scale of 1 inch to 1 statute mile, to be filled up by my own surveys of the interior. These I propose to reduce to a scale of 4 statute miles to 1 inch, to form one grand map; and finally, still further to reduce to a suitable smaller scale for publication and general circulation.

Besides the surveys made by myself during the first three years of this investigation, which have been already reduced to the 4 miles to 1 inch scale, plans have been drawn upon the inch scale, taken from Captain Kerr's most recent manuscripts, of a part of Placentia Bay, St. Mary's Bay, and Conception Bay; and I am now constructing a similar plan of Trinity Bay, from the same officer's original survey. All of these, with the exception of Trinity Bay, were placed for reduction in the hands of Mr. Robert Barlow, Draughtsman to the Canadian Geological Survey, and are no doubt progressing, although it may still be some time before they will be sufficiently far advanced to draw the geological boundaries thereon.

At page 44 of the 'Report of the Select Committee upon the Geological Survey of Newfoundland,' held last session of the Provincial Legislature, it will be seen that the scheme for carrying on the exploration of 1869 was proposed to be, by entering the interior from the Bay D'Espoir and to emerge at the Bay of Exploits, or some part of Notre Dame Bay; and for this purpose I had engaged four Indians from Conne River, procured canoes, and otherwise provided and equipped myself, when a desire was expressed to me on the part of the Government that I should visit

Bonavista Bay in the first place, in order to obtain some reliable facts regarding the existence of copper lodes in that region, which were at that time exciting considerable public interest. This was accordingly done; and being desirous to make the most of what at all times is but a limited season, I made an attempt to reach the central part of the island by the valley of the Terra Nova River, a large stream which discharges itself into Bloody Bay, Bonavista Bay, but was compelled to return in consequence of the impracticable character of the stream towards its upper waters for the navigation of canoes, and the extreme difficulty of portaging through a country at all times rough, but now almost quite inaccessible from the fallen timber, the result of a succession of conflagrations, which have devastated the region over an enormous area.

Returning from this expedition, I crossed from the Terra Nova Lake to Clode Sound, and thence proceeded to extend the examination from that part towards Green's Pond in Bonavista Bay, my object being finally to transport myself from the latter place, with all my equipments, with as little delay as possible to Bay D'Espoir, where I hoped still to have a commencement made of the originally proposed survey. In consequence of the absence of any direct communication between those parts, however, a good deal of delay and inconvenience was experienced before I arrived at my destination, and the season being by that time well advanced, I was unable to effect more than a limited preliminary survey in Bay D'Espoir, and make a hurried excursion thence into the interior for 40 or 50 miles by the valley of Bay East Brook.

Having engaged Mr. James Howley to act as my assistant during the season, I directed him to examine the rocks and collect specimens at various parts of Trinity and St. Mary's Bays, and to mark the boundaries of the different formations expected to be met with at these parts, while I proceeded into the interior. These duties Mr. Howley has performed very creditably. The facts he has ascertained, together with the fossil remains and mineral specimens he has collected, will be of great service in mapping the distribution of the formations, and may lead to information of much importance in the development of economic

materials. Mr. Howley likewise examined a section of country between Holyrood in Conception Bay, and Bay of Bulls on the Atlantic Coast, for the purpose of ascertaining the width of the Laurentian gneiss, mentioned in my Report of last year as forming a nucleus to that part of the peninsula of Avalon.

As the special object of my visit to Bonavista Bay was to examine certain localities, to which the means of conveyance was furnished by parties interested in the same, and I being quite unprovided with any independent means of transport except by two small birch-bark canoes, it was out of my power to accomplish more than a very superficial survey of the shores and islands; and much closer and more extended observation will be required before the true structure can be represented; yet the stratigraphical and lithological evidences at the various parts visited, are such as to leave little doubt on my mind that the greater part of the whole region is occupied by rocks of the same age as those described in last year's Report, under the heading of "The Intermediate System of Avalon." This remark, however, does not apply to the northern shores and some of the islands off it, which from Freshwater Bay to Cape Freels are of gneiss or granitic rock, and are supposed to be of Laurentian age.

By the kindness of Mr. Noonan, agent at Green's Pond for Messrs. Brooking and Co., I was conveyed from that station, with my party and equipments, to the Inner Gooseberry Islands, which I proceeded to examine, and was afterwards forwarded on by Mr. M. Carrol to Pitsound Island, and thence through the islands of Bloody Reach to the head of the Middle Arm of Bloody Bay, at the entrance to the Terra Nova River, the course of which was afterwards surveyed.

Survey of Terra Nova River.

The courses and distances followed on the ascent of this river, all minor turns excepted, together with the rise in falls, rapids, or currents, are represented in the following table. All the bearings are from the true meridian.

Courses.	Distances.		Rise in Feet.	Remarks and Particulars.
	mls.	chs.		
1st. S. 32° W. ..	3	73	12	From Garden Point at entrance on right side to junction of Maccles Brook on left side. The rise is nearly all within the lower mile, where there is a small chute with strong rapids.
2nd. S. 14° W. ..	1	70	Still water.	This bearing forms the chord of a bend in the river, up to an abrupt turn northerly.
3rd. N. 75° W. ..	0	60	Strong current.	River makes several sharp turns in this course.
4th. S. 18° 30′ W.	1	20	80	Total rise over the head of the lower rapids to the first still water above the lower great fall, including an allowance of 1 foot for current in the steady parts.
5th. S. 61° W. ..	1	55	42	Very strong rapids, and a succession of small chutes along this course.
6th. S. 43° W. ..	3	62	4	The lower part of this course is still water, but the last mile is rapid. Course terminates at a pool below the Grand Falls.
7th. S. 45° E. ..	1	0	134	From the still water in pool below the Grand Falls, to the still water at the head of all the falls and rapids. The main cascade is 45 feet.
8th. S. 45° E. ..	1	0	Still water.	River serpentine, making several turns, wide and with marshy banks.
9th. S. 67° 30′ W.	3	70		
10th. S. 63° W. ..	1	70	2	Estimated rise on the smooth water above the Grand Falls. The course terminates at the small island at the lower end of Terra Nova Lake.
11th. S. 67° W. ..	4	40	..	From island at foot of Terra Nova Lake to the entrance of main river above.
12th. S. 43° W. ..	8	40	25	From the outlet into Terra Nova Lake to the foot of a succession of cascades; the river making many minor turns in its course; generally flowing with a swift current, and very rapid approaching the falls, where our survey of the main river terminated.
Total	34	0	299	

From the island at the foot of Terra Nova Lake to the mouth of the north-west brook, the bearing is N. 86° 30′ W., 3 miles 38 chains.

The junction of the main brook, at the end of the 11th course was found, by mer. alt. of the sun, to be in latitude 48° 27′ 39″.

The principal tributaries of the river are the Maccles Brook, Pitts' Pond Brook, and the north-west brook of Terra Nova Lake.

Maccles Brook is a fine stream, which falls into the main river at the end of the first course, flowing from the north and north-west. It is said to proceed from an extensive sheet of

water called Maccles Pond, about 3 miles north-west from the lower great fall.

Pitts' Pond Brook joins the main river on the right side, about a mile and a half below the island at the foot of the lake. The stream is insignificant of itself, but it proceeds from a lake called Pitts' Pond, of considerable area, which is important as affording water communication to within about 2 miles of the sea at Clode Sound, and was the route by which we reached the latter place.

The courses, &c., along the route are as follows:—

Courses.	Distances.		Rise in Feet.	Remarks and Particulars.
	mls.	chs.		
1st. S. 49° E. ..	0	68	9	From the junction on Terra Nova River to the outlet from Pitts' Pond.
2nd. S. 55° 30′ E.	4	16	..	Along the main body of Pitts' Pond to a point on the eastern shore near the head.
3rd. S. 35° W. ..	0	50	..	Up a bay towards the outlet of a small brook.
4th. S. 64° W. ..	1	30	1	Up the brook and along the course of a small pond called Cobbler's Pond, to its head.
Total	7	4	10	To head of Cobbler's Pond—284 feet over sea-level.

The north end of the bay below Cobbler's Pond was found to be in latitude 48° 27′ 13″.

From a point on the south-east side of Cobbler's Pond, about 55 chains below the extreme head, a bearing S. 84° E. 2 miles 5 chains reaches the shore of Clode Sound, about a mile above Platter Cove.

Character of the Valley of the Terra Nova River.

The lower reaches of the river, below the lower great fall, flow for the greater part through a flat or undulating plain, sometimes of considerable width, of good soil, well adapted for agricultural settlement. The soil generally is light, being chiefly of sand deposited upon a subsoil of either blue or yellowish clay; but the spontaneous growth of birch and bushes, flowers and mosses by which it is clothed, are fair indications of its capability for producing many of the necessaries of life, under cultivation. That such is actually the case is sufficiently obvious, as may be seen on the small clearings on the shores of the bay, and at the mouth of

the river, where, although the system pursued is of the rudest and most primitive imaginable, it still yields fair crops of oats, grass, and various vegetables. At one time, not very remote, the whole of this part of the valley was densely clad with fine forest trees, but a succession of devastating fires, of which the most recent was in 1867, has made sad havoc among the timber, and left only limited tracts, or small isolated patches here and there, as representative of the past, which support a mixed growth of pine, spruce, balsam-fir, tamarack, white birch and poplar, sometimes of good size and quality. Above the lower great fall, the country becomes broken and irregular, rocky hills rising on either side not to any great height, but for the most part very rugged and precipitous, with occasional limited moss-covered sandy plains between the ridges. The timber here, as elsewhere, has at many parts been swept away by fire, and such as remains is of dwarfed size and scantily scattered over the surface. Some good flats occur upon the margin of the river, between the two great falls, but they are very limited in extent, both in length and width, and are frequently to some extent marshy, and not sufficiently elevated over the bed of the river to afford facilities for drainage.

Occasional patches of good light land also occur in the region surrounding Terra Nova Lake, and there is a considerable area of that description immediately south of the lower end and on the western side of Pitts' Pond; but on the same side of the latter pond, towards its south-west extreme, the country is nearly all marsh, while on the opposite or north-east side, abrupt hills rise, thickly covered by stunted timber, where the destructive influences of the great fires have not reached. A range of low, rugged, and abrupt hills, which rarely attain an altitude of more than 300 feet above Pitts' Pond, or between 500 and 600 feet above the level of the sea, constitutes the watershed between the streams falling into Bloody Bay on the one hand, and Clode Sound on the other; and the width of this dividing ridge, from the south-east extreme of Pitts' Pond to another considerable sheet of water called Dunsford's Pond, the waters from which are discharged at Bread Cove, Clode Sound, is scarcely half a mile. To the westward, towards Cobbler's Pond, the hills of the watershed die down, and the highest elevation between the latter pond and Clode Sound is

probably not more than about 400 feet above the sea, and is chiefly occupied by extensive marshes, alternating with low rolling ridges of rocky ground, which, except where denuded by fire, are covered with light stunted timber.

Of the Rocks and Associated Minerals.

The northern shores and islands of Bonavista Bay present nearly an unbroken front of granitic rocks from Cape Freels to Freshwater Bay. At first sight, as at Green's Pond, where much of the rock is granite, hard, solid, and compact, of a grey colour, containing large crystals of whitish feldspar, the impression is suggestive of the mass being intrusive; but closer inspection discloses facts which point to a different origin. Many of those masses, where the planes of bedding are externally imperceptible, will be found on being broken and closely examined, to have their mineral constituents arranged in parallel lines, the micaceous layers in particular being occasionally distinctly traceable in long thin streaks; and it was observed, moreover, that the masses alternate with distinctly bedded gneiss and mica slate; or, in other words, that the formation is an altered sedimentary deposit, cut through, however, frequently by granitic veins, mostly of a pale pinkish or flesh-coloured feldspar and quartz. A very minute description of these rocks is given in Mr. Jukes's 'Geology of Newfoundland,' p. 97, to which I beg to refer without further comment or quotation. It has already been suggested that the formation is of Laurentian age. In veins of white quartz, which are usually small but numerous, small quantities of metallic substances were frequently detected, among which were grey sulphuret of copper, specular and magnetic iron, while small pink garnets were often found, chiefly in the micaceous parts of the rock. At several places on the northern shore, where this gneiss is distributed, the lower and flatter parts are often spread over by a deposit of very fine white clay, which appears to be of the quality of kaolin, a substance which, under favourable circumstances, would be very valuable for the manufacture of porcelain. These clays are of recent formation, and have been derived from the feldspar of the rocks upon which they repose. Amethystine quartz crystals are abundantly sprinkled through these deposits, which have been

removed from crevices and drusy cavities in the granitic rocks, and are displayed in place at many parts of their run.

The rocks of the Gooseberry Islands, Bloody Reach, and Bloody Bay, are chiefly of slate, with quartzites and diorites, and a mass of slate conglomerate at or near the base, intersected by intrusions of granite or syenite, trap, and quartz veins. It has already been stated that the lithological resemblance these rocks bear to those of the intermediate system of Avalon is so striking as to leave little doubt of their identity, and the inference is still further borne out by the geographical position they occupy between the gneiss of the north shore of the bay and the Palæozoic formations (to be mentioned hereafter) of Trinity Bay. The horizons of these rocks are supposed to be equivalent to the divisions *b* and *c* of the section of last year's Report.

The southern inner Gooseberry Island is of a hard, black or dark green or bluish clay slate, with a mass of interstratified porphyry overlaid by a band of diorite, which runs from end to end of the island, and passes on in its course to Columbia Island; the general dip of the whole of which is nearly north-west, the rate of inclination varying from 40° to 53°. The cleavage planes are usually coincident, or nearly so, with the bedding. This mass of strata is intersected by a series of small dislocations, nearly at right angles to the strike, their bearing being N. 38° W., which are usually filled up with veins of quartz and calc spar holding the ores of iron and copper. These veins vary in width from less than an inch to upwards of 2 feet, and at some parts of their course are almost altogether constituted of a solid, dark grey, granular iron ore, together with copper pyrites, sprinkled through the adjoining quartz and calc spar. It was observed that the calcareous portions of the veins were mostly limited to the parts where they intersected the porphyry, where many reticulating veins of calcareous quality also formed droppers to the main veins. The main veins, however, seem to maintain throughout a decided parallelism, in which case no two of them are likely to intersect each other, a position in which metalliferous lodes are often importantly developed. The aspect of the iron ore, of which mention has been made, appearing in some respects to differ from any with which I was familiar, I was induced to send a specimen of it to Dr. Sterry Hunt for analysis, whose reply I have not yet received; but an

analysis by Messrs. Bath, of Swansea, kindly furnished by Smith McKay, Esq., M.H.A., who had sent specimens of the ore to England some time previously, gives the following results:—

Silica	5·0
Iron	39·0
Arsenic	33·0
Copper	0·8
Lime	1·0
Sulphur	20·0
Silver	2·72 oz. to the ton.
Gold	a trace.

Although the presence of the precious metals in this ore is unimportant as to economic value, the fact of their being present is in itself interesting, as it may justly give a reason to infer the possibility that the formation may prove to be sufficiently auriferous or argentiferous in some parts of its distribution to be remunerative.

The rocks which constitute the islands of Bloody Reach and Bloody Bay are chiefly of slate, with diorites and quartzites, and are likewise supposed to belong to the divisions *b* and *c* of last year's section. They exhibit many undulations along their course, and are frequently violently dislocated along the line of strike, which occasions many repetitions of the same strata. Similar disturbances are manifested in a high degree also among the islands and peninsulas to the southward of Bloody Bay, where the middle divisions of the intermediate system are most extensively displayed, until reaching the southern shores of Clode Sound, where there is a great development of red sandstones and conglomerates, representing the Signal Hill rocks, *e*, *f*, *g*.*

The slates and associated rocks of Bloody Bay strike up the Terra Nova River, and are more or less exposed on its banks, or at moderate distances back from them, to within 3 to 4 miles below the upper great fall, where they are interrupted by an intrusive mass of granite. They come in again in considerable volume on the south side of Terra Nova Lake near the outlet, whence striking generally in a S.S.W. direction, they leave the valley of the river, the rocks of which were found to be of gneiss or granite, to the farthest parts reached. The granite met with

* These are more probably Primordial.

below the Grand Falls, seems to be a huge dyke, nearly a mile in width at some parts, which bearing nearly due north and south, forms the islands on Pitts' Pond, and thence runs on to Clode Sound.

The veins of quartz with which the formation abounds in nearly every part of its distribution, run in some cases exactly parallel with the strike of the stratification, and at other times intersect it transversely; but the larger and better defined usually correspond with the strike of the beds. In nearly every instance these veins are more or less impregnated with the ores of copper, specular iron, and iron pyrites; but although the presence of these ores is so persistent as to be a characteristic of the formation, I have not yet seen nor heard of a single instance where the indications were such as to warrant a large outlay of capital with a fair prospect of a remunerative return. Indeed, such places as have already, to a small extent, been tested, do not appear to me to have been judiciously selected in the first place, and have in every instance one after another been abandoned, in consequence of the insufficiency of the material produced, to pay the working expenses. Such has been the case at Pitts' Sound Island, and at the mouth of the Terra Nova Brook, where, like many other places occupied by the same formation in Conception and Placentia Bays and other parts, notwithstanding the many beautiful specimens procured of various rich ores of copper, not one of all the localities that have been tried has yet proved sufficiently encouraging to establish a mine. The attempts hitherto made at mining operations in these rocks seem invariably to have been upon quartz veins, where the surface exhibited perhaps a little more than ordinary indications, especially of the grey or variegated ores of copper; while the great longitudinal dislocations, where the master lodes might with reason be expected, have been ignored altogether. At Pitts' Sound Island, for example, there are at least two such faults, running from end to end of the island, where copper ore is clearly indicated on the adjacent rocks where they are exposed, by the presence of green carbonate; but as the faults run for the most part along wet or marshy spots or in the beds of rivulets, a considerable amount of costeening might be requisite to prove the ground; and it is probably to this want of natural exposure that the neglect is to be attributed.

On the north side of Lakeman's Island, a set of strong quartz veins may be seen cutting the strata transversely, all of which exhibit beautiful specimens of the variegated sulphuret of copper, in bunches, small strings and spots, besides specular iron and iron pyrites in some profusion; but the quantity of ore, judging from the external display on the surface, is certainly insufficient to be remunerative. These veins, moreover, are not seen upon the cliffs of the south side of the island, from which circumstance it may be inferred, either that they thin out altogether, or are cut off by one of the longitudinal faults already referred to.

On the right bank of the Terra Nova River, about half a mile up its course from the mouth, an opening has been made on a quartz vein running in a fault, and cutting the strata, which include another vein of quartz, at nearly right angles. At the point where the quartz veins intersected each other, there is said to have been a good display of copper, and a shaft was sunk 24 feet in depth; a surface drift was also cut 36 feet in length by 12 feet in width, from which a few tons of ore were extracted, chiefly from the shaft. The shaft, however, being close to the bank, was shortly inundated by the waters of the river, and had to be abandoned. The surface drift appears to have been intended to follow the course of the fault, which is indicated by a slick-in-sided wall on the west side, until it should reach the intersection of a great quartz vein, about a quarter of a mile back from the river. This quartz vein is a very conspicuous one, running exactly on the strike of the strata, and is at many parts upwards of 8 feet thick; it may be easily traced for upwards of a mile. It appeared to me, however, on examination, to be *singularly barren* of any ore whatever, except some cubical iron pyrites, which occurs at intervals, rather than regularly along its course. Some few small openings had also been made along the run of the fault, but I could perceive no indication of ore worthy of attention.

The superficial deposits of the Terra Nova Valley are often very ferruginous, containing an ore of the quality of bog or tufaceous iron, to a remarkable extent. The sandbanks of Terra Nova Lake, of the lakes and ponds surrounding it, and of the river below, are cemented in some cases so rigidly by this iron ore, as to assume the appearance of a solid sandstone; and springs of chalybeate

water issue from beneath these deposits at many parts of the country. In the event of this region becoming inhabited, this ore can hardly fail to be of economic importance, although the destruction of the forests, which might have supplied the necessary fuel for smelting and other purposes, will doubtless be grievously felt.

The same valley contains a thick deposit of clay, usually of a blue, but sometimes of a yellowish colour, which is doubtless capable of being brought into use for the manufacture of bricks.

Having instructed Mr. Howley to examine the coast of Trinity Bay, while I proceeded into the interior, he accordingly began his work near Cape Bonavista, and with a few unavoidable interruptions, followed it round as far as Hant's Harbour on the eastern shores. While on this excursion, he visited Smith's and Random Sounds, Bay of Bulls' Arm (whence he crossed to Come-by-Chance in Placentia Bay), and several other of the principal great inlets. The following is a general summary of the information collected by him on that occasion.

Between Cape Bonavista and British Harbour (the latter being about 6 or 7 miles above Bonaventure Head), the rocks of the coast consist exclusively of the upper and middle members of the intermediate system; the slates and quartzites of divisions *c* and *d* of last year's section, surmounted by the sandstones and conglomerates of Signal Hill, *e, f, g* being again and again brought to the surface by a succession of undulations, and occasionally being repeated by a series of transverse faults, which usually run in a north and south direction. Veins of white quartz are abundant in this region as elsewhere in the same formation, the most regular and best defined of which run exactly parallel with the stratification. Many of these veins are charged with the ores of copper and with galena, and are particularly alluded to in that respect, as occurring in close proximity to Cape Bonavista, and in the neighbourhood of Catalina. The pyritiferous character of the slates of the latter place has long been known; the cubical crystals of large size and brilliant aspect having attracted attention, and acquired a local reputation as *Catalina stone*. A collection of quartz from sundry of these veins was made to be submitted for chemical analysis.

At or near British Harbour there is an evident change of

formation, and it would appear that a large tract of country to the westward of that part, including the whole or the greater part of Random Island, is spread over by rocks which, judging from the resemblance the fossils collected from various parts of the distribution bear to those lately described by Mr. Billings, are chiefly or altogether of Primordial Silurian age. The same formation further seems to occupy the west coast of Trinity Bay, from Random Sound to Bay of Bulls' Arm, on the western shores of which the older slates with the Signal Hill rocks again come up, and hold the coast to the southward to the neighbourhood of Chance Cove. At Tickle Harbour we again come upon the upper formation, which, according to Mr. Howley, occupies the whole or most of the coast, nearly to Old Perlican, forming a trough, the lower members of which rise with a westerly dip on the eastern shores, and with an easterly inclination on the peninsula between Tickle Harbour and Cottiers Bay, the higher measures in the centre being concealed below the waters of the bay. On both sides of Chapel Arm the strata are disturbed and altered by intrusive trap, sometimes rudely columnar, running on the axis of the trough. The trap, which is described as chiefly greenstone, comes out on the shore in a succession of dykes, the intervals between being filled up with a black shale, in which some fossils were found. Some of the trap also appears to be amygdaloidal, the cellules filled with pure white calc spar, in which patches and large fragments of black shale, together with great spherical concretions, are caught and mingled up confusedly with the igneous mass.

In consequence of the numerous and complicated folds by which these rocks are affected, together with the frequent dislocations and intrusions of trap, cutting up and throwing different parts of the formation into juxtaposition, Mr. Howley was unable to ascertain the thickness of the various strata of which it is composed; but the order of superposition seems upon the whole tolerably clear, and will probably be found to be nearly thus, in the ascending order:—

1. Red, green, and brownish sandstones with flaggy or slaty divisions, and beds of conglomerate.
2. Black shales or slates. Obscure fossils.
3. Reddish or grey concretionary limestone. Obscure fossils.

4. Red and green arenaceous slates and sandstones, with beds of limestone, the stronger and more prominent of the latter of which are towards the top, and are usually of a bright red colour. Fossils.
5. Red and green, sometimes blue or purplish slates, with an oblique and perfect cleavage, frequently of excellent quality as a roofing slate, and quarried for that purpose at some parts. The slates in some cases are overlaid by a band of compact whitish quartzite, which passes upwards into a reddish sandstone.

Variegated slates of Jukes.

6. Argillaceous shales succeeded by arenaceous and micaceous shales, and micaceous sandstones, with *Cruziana* and other fossils representing the rocks of the Bell Islands in Conception Bay.

The arenaceous deposits at the base of the formation must attain a much greater thickness and importance in Trinity Bay than they do in Conception Bay, while the black shales which overlie them are thinner or altogether absent. The two together, Nos. 1 and 2, represent *P, c* of last year's section; but while No. 1 is represented in Conception Bay by about 50 feet of conglomerate at Manuel's Brook, and by a narrow strip of reddish sandstone at Harbour Main and farther north, it is displayed prominently and in great volume on the shores of Trinity Bay on both sides; the succeeding black shales, which at Manuel's Brook are about 250 feet thick, being only exhibited in a few narrow belts on the east coast of Trinity Bay, on the west shore of Chapel Arm, and on the south-west end of Random Island. The sandstones of No. 1 occupy the coast of the mainland from the vicinity of British Harbour for nearly 11 miles to the westward, and all the eastern end of Random Island up to Skimmer's Cove (the strata being several times repeated by undulations), where they are succeeded by a concretionary limestone, No. 3. A series of calcareous strata, which at some parts holds obscure fossils, then succeeds to the westward, interstratified with red and green slaty and arenaceous beds, with a mass of red or flesh-coloured limestone at the top, which comes in on the eastern side of Britannia Cove, dipping by compass N. 65° W. $<$ 80°, or nearly vertical. Over the latter limestone there are the variegated slates of No. 5, and it would appear that it is in this latter division that the slates of the north shore of Smith's Sound are quarried. From British Harbour these rocks strike in a north-easterly direction, with a north-westerly dip, which, if not interrupted in their course, would bring them out on

the coast again near Keels in Bonavista Bay, where the existence of similar strata was long ago observed by Mr. Jukes, but as that section of the country has yet to be further and more carefully examined, it would be premature to advance further particulars.

A set of red and green sandstones, which were supposed to be an extension of the lower part of the formation No. 1, runs along the coast from Random Sound to the point of Bull Island, with a general dip to the westward, then striking up Bay of Bulls' Arm towards Mosquito Cove, they sweep round again from that locality towards Come-by-Chance, in Placentia Bay, where some of the lower members of the formation were observed in 1868, and were described in the Report of that year at page 165. The same, or very similar sandstones, present themselves at Bluff Head on the north side of Random Island, being apparently brought up on the axis of a subordinate anticlinal, and are again repeated on the mainland at the head of the sound between the bar and the bottom, where they are broken through by a mass of intrusive syenite. Most of the western end of Random Island, particularly on the northern side, is spread over by micaceous shales and sandstones, in which *Cruziana* and other fossils were found, indicating their horizon to be that of the Bell Islands in Conception Bay.

On the west side of Tickle Harbour, north of the Long Beach, there is an exposure of altered rocks, consisting of purplish and variegated slates, associated with serpentine and other steatitic rocks, together with layers of yellowish quartzite, which are intersected with quartz veins with asbestos. It is impossible, in the meantime, to say to what horizon these rocks ought to be referred, as the contact was not seen, either with the recognised portion of the intermediate system, or with the upper formation; their geographical position, however, is in favour of the probability that they belong to the intermediate system, and even may be low down in it.*

The upper formation of Trinity Bay would thus appear to be arranged in two rudely elliptical-shaped troughs, divided by a ridge of the intermediate system coming up between on the axis of a subordinate anticlinal within the great synclinal of the region.

* Further research has suggested the probability that this mass is intrusive (see Report for 1872).

The whole of the western shore of St. Mary's Bay seems to be occupied by Primordial Silurian rocks, chiefly, if not altogether, of measures lower than the Bell Island sandstones and shales, which as yet have not been recognised with certainty in any part of the peninsula. The lower measures exposed, which here consist of red and green sandstones, with slaty and arenaceous divisions, and a remarkable band of whitish, hard, and compact quartzite at the top, strike generally with the trend of the coast, and westerly dip, from the neighbourhood of Cape Dog to Red Head, where, turning off in a south-easterly direction, they disappear below the waters of the bay. At Red Head River these strata were found to be succeeded by a solid bed of fossiliferous limestone of a red colour, overlaid by r[illegible] and green slates, holding *Paradoxides* and other fossils, which [illegible]ter, striking along the shore southward of Red Head, constitute the cliffs for the most part to Branch Head.

Judging from the facts ascertained during the summer of 1868 and those collected this season, there would seem to be a large area of the peninsula between Placentia and St. Mary's Bay spread over by rocks of Primordial Silurian age, but the inland boundaries of the formation are still undiscovered; and the nature of the country, which is for the greater part concealed under enormous marshes, renders the task of following the outcrops always exceedingly difficult and sometimes impossible; nevertheless there is sufficient evidence to assume that the formation is divided into at least two troughs, one towards the shores of Placentia Bay, the other towards St. Mary's Bay. A prolongation of the eastern trough to the northward, by the valley of the Rocky River, would strike in the direction of the eastern trough in Trinity Bay, with which it may, on further research, prove to be united.

Among the economics of this formation are limestone, roofing slate, flagging stone, and building stone; the ores of copper, iron, and manganese have been observed at sundry parts of its distribution, and there are reasons for supposing that it is not impossible they may also prove to contain the precious metals.

The limestone is often of a quality suited for burning into lime; and the thicker beds are almost always fit for building purposes. In some cases the rock takes a high polish, and might be used as an ornamental marble.

The slates overlying the limestones are frequently of an excellent

description for roofing purposes, and can hardly fail to become hereafter of great importance among the natural products of the country. They have already been worked, and I believe profitably, on the northern shore of Smith's Sound, and Mr. Howley reports having met with them at several other places; among others, in Bay of Bulls' Arm, where the cleavage is perfect and the rock in ample abundance.

Flags may be procured from the arenaceous deposits at the base of the formation, and are especially alluded to by Mr. Howley, as being largely exhibited near Heart's Content.

The sandstones of Kelly's Island have been mentioned in previous reports as affording abundance of excellent building material; and although the fact is not stated by Mr. Howley, the equivalents of these rocks in Random Island may possibly be found to possess beds of equal importance. The syenite on the western shore opposite Random Island is said to be a very handsome building stone, comparatively easily quarried, and favourably situated for embarkation.

The metalliferous ores have usually been observed in quartz veins. Copper pyrites was seen at the head of Random Sound, in a vein of quartz about 2 feet thick, which intersects the strata bearing nearly east and west. The ore is thinly disseminated through the quartz. Specimens of quartz with copper were shown to Mr. Howley by some of the residents, reported to have been found near the eastern end of Random Island. A quartz crystal was also exhibited with a small speck of gold adhering to it, which *was said* to have been found on Random Island. All such statements, however, must be received with great caution. In St. Mary's Bay small quartz veins holding copper pyrites were observed near Cape Dog; and the same ore is reported as occurring near the little Barrachoix; but the latter locality was not visited.

Iron and manganese are often seen as a superficial deposit in the form of bog or tufaceous ore.

West of Foster's Point on the mainland, and nearly opposite Snook's Harbour on Random Island, a brickyard has been established, and the material produced is said to be of good quality. The clay from which the bricks are manufactured rises in a bank about 30 feet high, over the water's level.

Much of the land on both sides of Smith's Sound is reported as of excellent soil, in certain districts extending over large areas, where the surface is of a rich mould, unencumbered with boulders, and generally level or gently undulating. The north-western end of Random Island, and Britannia Cove on the same island, are particularly alluded to, as of this quality. The same character, to a considerable extent, applies to the country at the head, and on the northern side of Bay of Bulls' Arm, and also to portions of the bay region between Tickle Harbour and Heart's Delight. It is worthy of note that in each of these instances the country is underlaid by rocks of calcareous quality, which, beyond doubt, have played an important part in giving origin to the superiority of soil they display, to the more arenaceous or silicious parts surrounding them. Similar instances may be quoted, as occurring at the Bell Islands in Conception Bay, and on the calcareous regions on the Placentia and St. Mary's Bays' peninsula.

Excursion from the Bay D'Espoir up the Valley of the Bay East Brook.

The purpose of this excursion is explained at pages 188 and 189, to which I beg to refer. The chief object in view was to reach the serpentine region described by Mr. W. C. Cormack, which there is good reason for supposing will prove to be the equivalent of the Quebec group of rocks, and to follow out their distribution; but the season being far advanced by the time I reached the Bay D'Espoir, the examination was necessarily incomplete and cursory, although useful as preliminary to a more regular and systematic survey. In order to be prepared to carry out such a survey as early as possible during the following season, my canoes were left for repair (which they much needed) with the Indians who had been in my employ, at Conne; while my camp equipage was left in charge of the agent of Messrs. Newman and Co. at Gaultois. As I consider that a careful survey of this interior region will prove of essential importance in developing the geological structure of the Island, I beg most respectfully to recommend that the line of route proposed in the first instance for the operations of 1869 be followed up in 1870.

The route that was travelled commenced by making a portage

of between 3 and 4 miles, from the head of Bay D'Espoir in a westerly direction, to a large sheet of water known as Long Pond by the Indians, but called Sir A. Johnstone's Lake by Cormack, this being the lowest of a succession of lakes on the Bay East River. The height of this lake above the sea by aneroid was found to be 523 feet. It discharges its waters from the south-west end over a set of cascades and violent rapids, within a distance probably not exceeding 2 or 3 miles, into Bay East. The general course of the river upwards bears a little to the eastward of north for many miles. It consists of a chain of lakes, linked together by short and narrow streams, the lakes usually lying obliquely transverse to the trend of the valley. The lakes of this chain above Long Pond are called by the Indians Souli Pond, Brazil Pond, Burnt Pond, and Round Pond, the latter being between 30 and 40 miles from the mouth of the river, and the farthest that I was enabled to reach. Above Round Pond, according to the Indians, there is a stretch of river, more or less rapid for 10 miles nearly due north to Pipe-stone Pond, a name which may be presumed to imply the presence of magnesian rocks, and probably those of the Quebec group. Above Pipe-stone Pond the main river is described as turning sharply to the westward for a few miles, then opening out again in a large lake called Petiwickpegh, which is joined again by a short stream flowing from the north to another large lake called Wachtewbeesh, or Crooked Pond, said to be the principal source of the river. A small stream falls into Pipe-stone Pond at its eastern end, following up which a few miles reaches its termination at the watershed between the north and south flowing streams, a distance of half a mile or less dividing this head of the Bay East River from a stream which runs into the Exploits. I was further informed by the Indians that a canoe route could be followed without much difficulty from the eastern extremity of Long Pond to the Gander River and thence to Gander Bay.

In the immediate vicinity of the Bay D'Espoir there are tracts of good land, sometimes of considerable area, of which the valley of Conne River and portions of the shores of the bay towards its head are examples; all the region towards the sea is densely covered with forest, in many parts yielding stout timber of the usual varieties. Much of this fine forest, however, is rapidly and wastefully being destroyed, not so much by the nearer inhabitants,

whose interest it is to protect it, as by a host of intruders from St. Peter's, Placentia Bay, and many other parts, who annually load a fleet of small coasters with the choicest cullings, while at the same time the smaller timber is recklessly cut down, for no other purpose whatever but to encumber the ground.

After leaving Bay D'Espoir on the route to Long Pond, when the heights are attained, which rise sharply within about a mile to 760 feet, the country opens out into great marshes and barrens, partially timbered with straggling trees and small groves; and this character, alternating with dense thickets of small stunted woods on the slopes towards the watercourses, may be said to obtain over the whole region. The country surrounding the chain of lakes is almost all more or less mountainous, although the hills in no case reach any remarkable altitude, but are often rugged, rocky, and bare; and with the exception of a few isolated spots on the lower grounds, no land was seen worthy of special notice as being capable of agricultural improvement. On the other hand, should the interior prove to be metalliferous, which seems highly probable, the facilities offered for reaching it, in a great measure by natural water communication, must be obvious.

Regarding the distribution of the geological formations, little can judiciously be said until the country is somewhat accurately surveyed and mapped. On both sides of the upper part of the Bay D'Espoir, and inland for a few miles to the northward, the rock is chiefly a black plumbaginous slate, interstratified with thin bands of compact sandstone, of a grey colour on fracture, weathering yellowish. The shales or slates are sometimes slightly calcareous. Taken as a whole, the rocks exposed on the shores of the bay dip at a very moderate angle to the northward; but they are very much disturbed and corrugated at some parts, and the same strata may frequently be seen in the cliffs along the shore, repeating themselves in a succession of wave-like undulations for considerable distances. These rocks are traversed by numerous quartz veins, which occasionally are also calcareous, and in many cases contain the ores of copper and lead, together with iron pyrites. The presence of other substances was also observed, but not being identified, specimens were collected to be submitted to chemical analysis. At page 94 of my Report for 1866, under the head of plumbago, the views then entertained for the probable

horizon of these rocks is mentioned, and as yet no evidence has been discovered to change or modify the opinions there expressed.

The country to the westward of the chain of lakes is to a great extent occupied by granitic or gneissoid rock, while that to the eastward is chiefly of slate with quartzite and trap. The lithological resemblance which the latter rocks bear to certain parts of the intermediate system is suggestive of their geological horizon, but nothing can be said with safety in this respect until the region is more thoroughly examined.

From all the facts hitherto ascertained, and described with more or less detail in this and former reports, it may be observed that the geological formations of the eastern and southern parts of the Island are all lower in stratigraphical position than the rocks of the Quebec group; and although many ores, and minerals of various descriptions, are found to exist within the range of the more ancient deposits, the conditions and circumstances under which they occur are essentially different from those of the newer formation, of which the mine at Tilt Cove is an example; and it may further be stated that the structure, so far as our present imperfect evidence can be depended upon, tends to show the improbability of rocks contemporaneous with those on the south side of the Cape St. John peninsula being found to the eastward of a line drawn roughly through the island, from Fogo to the head of Placentia Bay.

In conclusion, I beg permission to remark that this and all such annual Reports of progress must be considered as mere outlines of such facts as may from time to time have been observed, especially during the season to which they refer; and it will not be before a trustworthy topographical map has been constructed, the fossils from various formations examined and described, and the rocks and minerals submitted to chemical analysis, that the geological boundaries can be drawn and details given with any degree of accuracy. When this has been accomplished, a condensed report of all that has been learned could be published with confidence, and it is to be hoped would contribute its quota of useful public information, and help to lead towards the progress and prosperity of the colony. As stated at the commencement of this Report, the necessary mapping is in progress, and the fossils and minerals are under examination; but as an instance of the care

and study required to come to a definite decision on such matters, I quote the words of Mr. Billings, the distinguished palæontologist of the Geological Survey of Canada, who says in his last letter to me on the subject of fossils: "I labour under disadvantage in this way; that I may study a collection for two or three months, and not be able to arrive at a conclusion sufficiently well grounded to justify the mapping of a single square mile." And again, Mr. Billings says: "Often the result of a month's most serious consideration may be given in ten lines of one of our reports."

I beg further to call attention to the first paragraph in the eleventh page of the Report of the Select Committee on the Geological Survey, where it is recommended that a "suitable building or apartment be provided for the deposit and arrangement of ores, fossils, and other specimens," which hitherto has not been obtained; and in consequence my office is within my private dwelling, while the bulk of the collection (excepting the specimens which were sent to Canada) are deposited in an outhouse of my premises. By being furnished with a suitable office, where maps could be exhibited and illustrative specimens arranged access being free to all who took interest in such matters, a considerable amount of useful knowledge might be acquired; and the public would have an opportunity of judging for themselves of the amount of labour requisite to carry out such an investigation as I am engaged in, at any part of the world, but more especially in a wild and unopened country like Newfoundland.

With much respect, I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

To His Excellency Col. Hill, C.B.,
Governor of Newfoundland, &c. &c. &c.

CHAPTER X.

REPORT FOR 1870.—SURVEY OF BAY EAST RIVER—MR. HOWLEY'S EXAMINATION OF SUNDRY PARTS OF THE COAST.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, NEWFOUNDLAND, 1871.

MAY IT PLEASE YOUR EXCELLENCY,—

The extended means which were so liberally granted for the prosecution of the Geological Survey, last session of the Legislature, by the recommendation of your Excellency and the Executive Council, have enabled me to make more rapid progress in the investigation during the late season than was possible in the same space of time any previous year. The field work which has been accomplished is of considerable extent, and will, it is hoped, be found both interesting and important; while the acquisition of a building in which to establish an office, and wherein to deposit a collection of specimens, has placed the Survey in a position to be useful as a public institution, either as affording information respecting the resources of the country, or instruction to those who may feel an interest in matters of scientific inquiry.

The collection, however, which has been made from time to time on the several explorations, has now accumulated to such dimensions as to require much more room for exhibition than the building it is now deposited in is capable of affording; and as such a collection is a most important auxiliary in studying out the structure of the country, as well as an illustrator of what has been ascertained, it is most highly desirable that some suitable place should be appointed to receive it. Of fossils alone there is now a large collection, the classification of which, arranged so as to represent the age or stratigraphical position of the several formations to which they belong, is one of the first and most necessary steps in forwarding a geological investigation.

For reference on some points, and assistance in various ways, I have hitherto been much indebted to Sir W. E. Logan,

Mr. Selwyn, and the officers of the Geological Survey of Canada generally, and especially to Mr. Billings, the palæontologist of that institution, for having examined and named most of the organic remains that had been collected previous to the year just expired, and who also has supplied me with a small but useful arrangement, classified and catalogued, of the typical forms of organisms belonging to the successive epochs as displayed in Canada, which for comparison and illustration are of great value.

To R. C. Selwyn, Esq., the present Director of the Canadian Survey, I am much indebted for the magnificent geological map of Canada, which was most kindly and considerately presented to me, and which I had the honour to exhibit in the early part of last year before your Excellency and the Legislature.

Various samples and specimens of ores and minerals have also been referred to Dr. Sterry Hunt, of the Canadian Survey, for examination and analysis, which, as far as his time would permit, have been kindly attended to, and the results of some of those inquiries are now in my possession; but the time that necessarily elapsed before such specimens reached their destination, were examined, and finally returned, was found to be so very inconvenient, that I felt justified in availing myself of the services of Mr. R. C. Hennessey, at present residing in St. John's, to make such chemical assays as I considered immediately necessary.

Notwithstanding the advance that the Survey has made up to the present time, there is still much to be accomplished before it would be either prudent or expedient to attempt to enter upon a condensed report of the whole subject. The field work must still be extended over a vast area of country; a general map, with all the ascertained facts recorded thereon, must be constructed; sections drawn to represent the structural arrangement and sequence of the formations; besides many other matters of detail, involving much labour, study, and time. The present Report, which I now have the honour to lay before your Excellency, must therefore be, in common with those which preceded it, a simple history of the manner in which the investigation has been conducted during the past season, with such conclusions as may have been arrived at from the evidences observed.

To render geological subjects properly intelligible, many illustrations are absolutely necessary, and there being no means of

getting such executed either on wood or stone in St. John's, I have been obliged heretofore, wherever a drawing was indispensable, to have the necessary work done at Montreal, under the superintendence of Sir William Logan. This has been, and still is, a most formidable inconvenience, as through the medium of those illustrations a lengthy and wordy text is avoided, and the subject-matter made clear and explicit.

As stated in my Report of last year, my intention is, eventually, to have a map of the whole Island constructed, which will include my own and all other surveys that can be procured, upon a scale of 4 miles to 1 inch; but as I have in the meantime, through the kindness of Staff-Commander Kerr, R.N., been supplied with a general map of the coast survey, I have been engaged for some time past in reducing my topographical plans upon it, and colouring in the geological formations, so far as ascertained, which will be useful for present purposes, and will be to some extent a guide for future explorations.

The staff appointed to carry on the investigation for the past year was arranged into two parties; one under myself, consisting of an assistant and five Indians, with whom and with three canoes I proceeded into the interior of the country from the Bay D'Espoir,* and by the valley of the Bay East River, as proposed in last year's Report; while the second party, under Mr. James P. Howley, who was provided with a small vessel and crew, and a miner, was directed to examine certain parts of the coast, and make collections of rocks, ores, and fossils.

Survey of the Bay East River, its Tributaries, and the Surrounding Country.

This survey was effected in the same manner as those of former years, by measuring distances along the course of the streams or along the shores of the lakes by Rochon's micrometer telescope, the bearings being taken at each measurement by prismatic compass, a system of triangulation being kept up

* Usually called Bay Despair, but I have preferred to adopt the original word as more applicable.

throughout by theodolite or pocket sextant, while checks were kept upon the whole by frequent observations for latitude and variation of the compass.

The Bay East River is one of the largest and most important of the south-flowing streams of the Island, draining an area of nearly 720 square miles of country. Rising in about the latitude of 48° 30′, and between the meridians of 56° and 56° 20′, it falls into the Bay East Arm of Bay D'Espoir, about latitude 47° 50′, and longitude 55° 57′. At pages 205 and 206 of last year's Report a brief description is given of the character of this river and the region through which it flows; but the statements in that Report were the result of such observations only as could be made during a hurried excursion at a late season of the year, or founded upon information derived from the Indians. The more careful survey that has been accomplished since has proved some of those statements to be somewhat inaccurate, as the following topographical detail will show. As stated in the Report referred to, the river consists of a chain of lakes, of which Long Pond is the lowest, linked together by rapid streams. The lower or extreme southern end of Long Pond is in latitude 47° 58′, very nearly on the same parallel as the extreme head of Bay D'Espoir, and 5 miles 60 chains due west from the latter. From this point the stream issues, flowing with great velocity in a nearly due south course to the sea at Bay East Arm, the head of which, according to the coast survey map, is in latitude 47° 50′. This would make the distance between the outlet of Long Pond and the sea 9 miles 16 chains in a straight line, instead of between 2 and 3 miles, as stated in last year's Report; but as it would appear, according to some observations taken by myself, that the northern coast of Bay D'Espoir is placed somewhat too far south upon that chart, the direct distance in reality probably does not exceed 8 statute miles.

Long Pond, as its name implies, is long and narrow, of a somewhat serpentine form, bearing from the outlet to the extreme head about north by east.* The total length of the lake is 9 miles 40 chains in a straight line, the width varying from less than a quarter of a mile to upwards of a mile, the average being about 60 chains, which would give a superficial area of a

* All bearings are given from the true meridian.

little over 7 square miles. The height of Long Pond above the sea was found by aneroid to be 523 feet. The main river enters the lake on the western side, about equidistant from each of its extreme ends, and its upward course bears, exclusive of sinuosities, a little west of north for between 2 and 3 miles, above which it bends sharply round again to the southward for about a mile, when it expands, still bearing in a southerly direction into Soulis Pond, which lies nearly parallel with the southern end of Long Pond, a low range of hills dividing the two. The area of Soulis Pond is about 3½ square miles, and its height above the sea is 550 feet. A broad and very rapid stream of only a little over half a mile in length falls into Soulis Pond on the south-west side (about 3 miles from the lower end of the lake), which joins to Brazil Pond, the next of the suite ascending. The course up Brazil Pond is N. 30° W., and the total length from foot to head a little over 4 miles, the width varying from under 10 chains to upwards of 85 chains, or at an average of 46 chains. The area would thus be about 2½ square miles. The height of the level of Brazil Pond above the sea is 575 feet. The next expansion proceeding upwards is known as Little Burnt Pond, which is connected with Brazil Pond by a sinuous stream of about a mile and a half along its course, and falls into the latter on its western side, a little over a mile from its extreme northern end. The course up Little Burnt Pond is nearly due north, and the distance from foot to head is 2 miles 70 chains. The area of Little Burnt Pond is a little under 2 square miles, and the height of its surface above the sea is 586 feet.

The river falls into Little Burnt Pond at its extreme northern end, and is the connecting link between it and Round Pond, one of the largest of the suite. The course of the stream is first due north for about 50 chains, and afterwards north-west for about 50 chains more to the still water of the lake above. The stream is extremely rapid, and is broken at one place by a succession of chutes which altogether fall from 20 to 30 feet. Round Pond is entered by a long and narrow arm, bearing due north for about 3 miles, beyond which it opens out in a fine sheet of water, of a rudely elliptical shape over the main body, but indented by numerous extensive bays and coves, and picturesquely dotted over by many islands of various sizes. The superficial area of the

whole is about 14 square miles, and the height above the sea was computed to be 681 feet.

The following courses along the bed of the stream above Round Pond, exclusive of minor turns, reach to Pipe-stone Pond.

No. Course.	Bearing of Course.	Distance.		Remarks.
		miles.	chs.	
1	N. 18° E.	1	5	From outlet into Round Pond up to a bend in the river.
2	West	1	40	Above the first bend up a shallow arm of still water, with low marshy islands, the river coming in at about 85 chains on the north side.
3	North	4	30	From river junction of No. 2, strong rapids and chutes alternating with long reaches of still water; a large tributary joins on left side within the first mile.
4	N. 72° W.	2	10	From termination of No. 3, river rapid at some parts, but in great part still water.
5	N. 15° W.	3	72	From termination of No. 4, open and still water, alternating with very strong rapids and chutes. This course terminates at the outlet of Pipe-stone Pond.

From the end of the last course a bearing S. 46° W., 50 chains, reaches the junction of the main river, which flows into Pipe-stone Pond at its south-western extreme. The lake stretches away to the northward, and is divided into two expansions, of nearly equal size, about the middle, by a narrow channel. The general bearing from the south-west end is N. 16° E., 3 miles 50 chains to the northern angle of the lake, where a tributary falls in from the north. The area of the two expansions is considerably under 1 square mile, and the aneroid gave the elevation of the lake's surface to be 823 feet.

Following the main river above Pipe-stone Pond, the general course is nearly due west, and the distance rather under 2 miles to Petiwickpegh, or Great Burnt Pond, above which and to the westward there are two more large lakes, connected by short and rapid streams, known as Wachtewbeesh, or Crooked Pond, and Island Pond. A stream falls into the latter from the northward, the sources of which are interlocked with some of the tributary waters of the Exploits; while another comes in at its south-west angle, which leads to waters falling into Meelpegh, one of the great lakes visited by Cormack, and supposed to be the head

waters of the Little River, which falls into the sea between Cape La Hune and White Bear Bay.*

Another lake of the system, called Elnucheibeesh Gospen, or Indian Sit-down Pond, lies immediately west from and parallel with Pipe-stone Pond and the upper reach of the river (No. 5 course). The length of this lake is 5 miles 40 chains, and its average width about 50 chains; the area of surface about 3·4 square miles. The upper end bears due east from the north end of Pipe-stone Pond, at a distance of 2 miles, and its waters are discharged by the channel of a small stream flowing south-east from its southern extreme, into the main river near the termination of No. 3 course.

The tributaries which fall into this river are very numerous, and some of them are sufficiently large to admit of partial canoe navigation when in good order, affording convenient communication towards the head waters of the streams which discharge themselves at various parts of the coast, both to the north and to the south. One of those comes in at the extreme northern end of Pipe-stone Pond, which, bearing upwards in a northerly and north-easterly direction for a few miles, and sweeping along the base of the Jamieson Hills of Cormack, leads to the summit level within a very little distance of one of the feeders of the Exploits. The latter river is frequently visited by the Indians in deer-skin canoes and flats by this route, and also by the route from Island Pond.

Another important tributary joins the river on the left side, a little under a mile from the 3rd course above Round Pond, which in ordinary seasons is navigable for canoes, with the exception of a few short portages, to a suite of small lakes at its head, the lower of which is called Newfoundland Dog Pond, and from whence a portage of 1 mile over a level but marshy country, terminates on one of the sources of the Gander River. From this source, which

* In consequence of the almost uninterrupted drought that had prevailed throughout the summer, the rivers were by the time we had surveyed Pipe-stone Pond so reduced in volume as to be in many parts nearly dry, and utterly unfit for canoe navigation, which compelled us very reluctantly to return without having accomplished the survey of the upper lakes. This will account for the area and height of those not being given. Great Burnt Pond was reached on foot; and judging by the rate of the current and the rise upon some of the falls and rapids, its surface is probably nothing less than 70 feet over the level of Pipe-stone Pond, or 900 feet above the level of the sea; and the level of Island Pond may be fully 950 feet.

also consists of a string of small ponds, the canoe route usually is perfect, with the exception of a few portages towards the upper end, to the sea at Gander Bay, Notre Dame Bay. It was by this route that the survey was intended to be conducted, which would have completed one section of the Island from south to north; but as the Gander River proved upon reaching it (which we did on foot) to be in the same dry condition as the streams we had left, and with the prospect of having to carry our canoes and baggage for nearly 40 miles, the scheme had to be abandoned.

I have been thus particular in describing the hydrographical character of this part of the Island, in order to show its capabilities for water communication, which will at some future day be found of much importance, when the metalliferous regions which the lakes and rivers intersect are opened out.

Geographical Character.

Judging from the experience of this and former years, a great part of the central regions of Newfoundland may be described as a vast undulating plain or plateau, which, rising abruptly from the southern sea-shore to an elevation of over 700 feet, slopes gradually upwards towards the watershed in the middle of the Island to a height probably not greatly exceeding 1000 feet, and which is bounded by elevated mountain chains on the east, and on the west. The undulations of this great plain consist alternately of low rounded hills or ridges, and great level marshes interspersed by numerous lakes, ponds, and tarns. The prevalent bearing of these alternate features is about north by east and south by west from the true meridian, or north-east and south-west by compass. The height of the hill ranges over the general level of the plain rarely exceeds from 300 to 400 feet, although they are occasionally broken by isolated summits reaching to 600 feet and upwards. The flanks of the hills are usually timbered more or less by detached woods of the usual varieties, but the summits are for the most part bare, or only support a straggling growth of dwarfish tamarack, small spruce, and white birch. The valleys are occasionally well wooded, especially the fringes of the water-courses; but by far the greater part of the low ground is open marsh or bog, where, over a great accumulation of peat, the only

vegetation consists of a wiry grass, aqueous plants, berry bushes, and moss. The most lofty summits over the valley of the Bay East River and its tributaries are the Witch-hazel Hills which rise over the southern ends of Soulis and Brazil Ponds; the White Hills, south-westward of Round Pond; the Jamieson Hills, between Pipe-stone and Elnucheibeesh Ponds; the Partridge-berry Hills, over the watershed between the Bay East and the Gander Rivers; and a ridge of which the highest summit is known as Through Hill, about 5 miles east from the head of Elnucheibeesh. The Witch-hazel Hills rise in three precipitous and rugged peaks, the lowest and most northerly of which is 997 feet, and the highest about 1200 feet, above sea-level. The Partridge-berry Hills are 1253 feet, and the others, enumerated above, were assumed to average about a mean of the three. To the eastward and north-east of the valley, however, and between it and the eastern mountain belt, there are three remarkable hills, called Tolts,* which tower over the rest of the plain, and rise to a height of probably over 2000 feet above the sea. The most southern of those was named by Cormack Mount Sylvester; and the three being about equidistant from each other, serve as beacons to guide the Indian and the traveller from Piper's Hole to the River Exploits. The position of Mount Sylvester was roughly fixed from the heights over the Piper's Hole River in 1868. The position of the others is given as described by the Indians.

The agricultural capabilities of this interior country are certainly not great, yet there are numerous detached spots, chiefly upon the margin of the lakes and streams, which might be taken into cultivation as auxiliary to other industry. The timber for the most part is small, but among it there are many pines, spruce, tamarack, and fir, fit for ordinary purposes, such as building, bridging, road-making, timbering excavations, or erecting telegraph poles. At some parts also white birch attains a large size, although where that timber is in greatest abundance, it is of a second growth, and is tall and slender, having replaced the original evergreens previously swept away by fire. When mixed with the usual forest the birches often have a diameter of from 18 inches to 2 feet; and one grove was observed near Pipe-stone

* The Tolts are Mount Sylvester, Blue Hills of the Gander and Gambo or Mount Peyton, Hodge's Hill on the Exploits.

Pond where the bark of some trees was large enough for the construction of Indian canoes.

As this region over an extensive area gives evidence of the presence of metalliferous ores of value and importance, the means by which those may be developed and utilised, remotely situated as they are from the coast, is a matter for consideration. The construction of a road or telegraph line intersecting the Island from shore to shore is the first step that suggests itself to the traveller, as likely to lead to that end, as there are unusual facilities for such a construction directly through the mineral country, which would also give direct communication from south to north. Such a public work could scarcely fail to be an essential element towards the future progress of the colony. The route, which is now constantly travelled by the Indians in their migrations between Bay D'Espoir and Hall's Bay, and which journey they perform in about eight days, has probably advantages for road-making not possessed, for the same distance, by any other part of the country. After ascending the heights at the head of Bay D'Espoir, a set of barrens high and dry over the level of the great plain, with only a few interruptions in certain depressions, is followed on a course N. 10° to 15° W. to the head of Newfoundland Dog Pond, and close to the source of the Gander River. From this point the watershed is kept, which divides the tributary waters of the Exploits and Gander Rivers to the valley of the main Exploits. According to the accounts given by the Indians, the Exploits River, below where the route strikes, is at all times navigable for canoes, and is only interrupted by one portage not over a mile long to its outlet into the sea. The banks of the river also are described as affording good ground for the pedestrian from the sea to the Red Indian Pond.

Another route frequently travelled by the Indians to the Exploits is from Piper's Hole, at the head of Placentia Bay; but as the course of that route traverses obliquely over a succession of ridges with lakes, rivers, and marshes lying between, where much bridging and other work would be necessary in constructing a road, it must be considered as inferior and more expensive than the former route would be, which keeps nearly on a level all the way, and where bridging would be to a large extent avoided.

While my own attention was turned to the examination and

survey of which the above is a general outline, Mr. Howley was directed to examine various parts of Fortune Bay, Langlois Island, of the Miquelon group; the shores between Point May and Cape Chapeau Rouge; certain parts of the shores of Placentia and St. Mary's Bays; and, finally, to proceed to Trinity and Conception Bays; the ultimate object being to determine the boundaries of the Primordial Silurian rocks of those regions, and to ascertain the relation that formation bears to the formations above and below, at the different localities.

Independently of the geological importance of obtaining correct information regarding the distribution of the Primordial Silurian group, the boundary lines of that formation may be taken also as including the lands best adapted for agricultural pursuits, in those sections of the Island over which its strata are spread. In my Report of last year, at page 205, it was remarked that the soil of the country occupied by rocks of this age was in nearly every case found to be of excellent quality, and that the land was usually level or gently undulating, while at some parts it was almost altogether unencumbered with boulders. In a great measure this character applies to all the detached superficial areas that have since been examined; and as the cultivation of the soil may become shortly a most important industry, I am desirous to call your Excellency's attention to the highly imprudent and unsatisfactory manner that is adopted at present in settling upon some of these lands.

In former reports I have frequently urged that a systematic plan for laying off Crown lands should be adopted, wherever the nature of the country was susceptible of improvement, whether for the purpose of farming, lumbering, or mining; and the experience of this year more than ever convinces me that unless some means are shortly taken in this direction, the province will eventually suffer an irretrievable loss by the sacrifice of its best and most available lands, in indiscriminate and injudicious distribution.*

My attention has been particularly called at the present time to this subject, by the representations of my assistant, Mr. Howley, whose statements regarding the capabilities of the

* In my evidence before the Select Committee of the House of Assembly, I proposed a *principle* for laying off lands. See the Report of the Select Committee upon the Geological Survey, pp. 38 and 39, A.D. 1869.

country in some parts of Trinity Bay, and especially in the vicinity of Random Island and Smith's Sound, are worthy of serious consideration. Mr. Howley states that the soil in Random Island, west from Snook's Harbour and the mainland opposite, between Foster's Point and George's Brook, at the head of Smith's Sound, is rich and deep, and almost entirely unencumbered with boulders. The surface is gently undulating, and is never more than from 80 to 100 feet above the sea-level; it is thickly wooded by timber of remarkably fine quality, which is fit for all the purposes required in pursuing the occupations either of farming or fishing. The land is very easily reclaimed; all that is required being to remove the timber and introduce the plough, when it can immediately be brought into cultivation. There is always a great accumulation of seaweed along the shores, which, together with fish offal and other manure, would make rich compost. As it appears to be probable that the geological formation of this part (Primordial) extends entirely across the peninsula to Goose Bay, Bonavista Bay, Mr. Howley is of opinion that a corresponding amount of good land may be found more or less over the same area.

In addition to the superior quality of the soil, the same neighbourhood possesses sundry other peculiar advantages; it contains an ample supply of building stone, limestone, flags, slates of an excellent description, and brick clay, which is also fit for coarse pottery, added to all of which, water power for driving machinery may be easily procured from the numerous streams that fall into the Sound. It is frequently urged (but chiefly by those whose experience is limited to the open coast) that the climate of those regions is unfavourable to agricultural pursuits being carried on advantageously. By Mr. Howley's account these representations are not quite in accordance with fact. He states (and he has also the authority of several residents for so stating) that the climate at the head of the Sound accords with that of the interior, and is free from the influence of fog, which may often be seen blocking up, as if by a wall, the open bay to the eastward; while immediately around, and to the north and west, is a clear transparent atmosphere, with a warm and genial temperature. In proof of this being the case, Mr. Howley mentions having seen tobacco experimentally grown in the open air, which came to available maturity.

Mr. Howley then remarks that these manifold advantages have attracted a great number of people to those regions, who come to settle or squat upon the shores year by year, and who pick out the most available spots for a combination of fishing and farming, in utter disregard to the value of the back country, or the means by which it is to be entered. No spaces are left for roads, or any attempt made at order in establishing boundary lines of property; consequently the whole rear country will probably long remain unoccupied, as settlers who might otherwise take up those lands for the sole purpose of farming, would naturally reject even a free grant of such when they find themselves deprived of access to the seaboard, and forced to make their boundaries conform with those of their irregular predecessors.

Distribution of the Formations.

By far the greater part of the southern part of the Island between Cape Ray and the extreme head of Fortune Bay is occupied by rocks of a gneissoid character, with granite, syenite, and trap. The prevalent character of the gneiss seems to be of the orthoclase variety, described in the 'Geology of Canada,' p. 474. The colour most usually displayed is red or reddish, but it also is at some parts grey and sometimes whitish. In some cases the gneiss is micaceous, at others it is hornblendic, and frequently a combination of both qualities, while those minerals are nearly or altogether absent on many parts of its distribution, and the rock approaches the character of felsite. Garnets of large size are sometimes found in the gneiss, especially in the micaceous or hornblendic varieties, some of which may occasionally be fit for gems.* Large masses of a black hornblendic rock were observed confusedly entangled with the gneiss at the western end of the Island, and particularly near the Dead Islands; but that mineral quality does not appear to be in such volume farther east. Quartzites also are frequently banded with the other crystalline rocks, often revealing the stratification where it would otherwise be difficult to detect. In the explorations of last season, from

* The locality in particular where these large-sized garnets have been found is near Port-aux-Basque. Many of them have a diameter of one-third of an inch or more.

Mal Bay, at the head of Fortune Bay on the east, to the Rameo and Burgeo Islands on the west, nearly the whole coast was found to be of gneiss, intersected by various intrusive rocks; and at both the latter places the rock is a whitish coarse-grained granite. The colour of the gneiss westward of Mal Bay is for the greater part a flesh-red or brownish. Mica is rare, and when present in the minutest scales, while hornblende is not abundant; but there are associated strata where mica and hornblende, or both, form the chief constituents, in which cases the colour is blackish or grey, and these are always characterised by the presence of minute pink garnets. There are also masses of granitoid gneiss of a very coarse texture, containing large cleavable crystals of whitish or pink feldspar, combined with translucent quartz, mica, and hornblende, the latter black, or of a bottle-green colour.

At St. John's Head, Fortune Bay, a section of three massive beds, each about 10 feet thick, is as follows, ascending on a dip east, $< 56°$, the lower bed coming in contact with a dyke of feldspar porphyry, which has disturbed both the gneiss and a newer conglomerate, to be described hereafter:—

1. A very compact quartzite, resembling chert of a pale drab colour, with numerous black or dark brownish specks or crystals, some of which assume a lenticular form, and small crystals of iron pyrites; the planes of stratification are very distinctly marked by alternating layers of lighter and darker colour.
2. Pale pinkish gneiss, with very small grains or specks of translucent white quartz, and small cubes of iron pyrites, which are arranged rudely parallel with the stratification.
3. Bright brick-red felsite, in which some small crystals of quartz are disseminated, and contains isolated crystals of iron pyrites.

The interior country and peninsulas between Mal Bay and Pass Island, with the exception of some of the extreme points, are occupied by gneissoid rocks, corresponding to the descriptions given above, the hornblendic gneiss being most conspicuously displayed at Pass Island, where a portion of the strata consists of black hornblende and white quartz in nearly equal proportion, which contain a great profusion of very minute rose-coloured or pink garnets. To the northward gneissoid rocks were observed on both sides of Hermitage Bay, and at Gaultois on Long Island, there is a good display of coarse granitoid gneiss, with large

crystals of feldspar combined with quartz and hornblende, and occasionally mica. At Gaultois the gneiss is intersected by numerous small feldspathic dykes and white quartz veins, which on some parts of the cliffs on the sea-shore may be seen reticulating in all directions, cutting up and shattering the strata into blocks of all sizes and shapes. The dyke at St. John's Head, which may be taken as a representative, in mineral character, of the principal intrusive masses of the region, is a feldspar porphyry, the base being a red feldspar, mottled with yellowish spots of a soft decomposing mineral (probably feldspar), varying in size from mere specks to angular or rounded patches, with a longer diameter of nearly half an inch; coarsish grains of translucent white quartz, and a black or brown material, which is very soft, and yields easily to a sharp-pointed instrument, in small dots or crystals.

Proceeding to the north from Gaultois, by the Long Island Channel, the contorted gneiss, with many granite intrusions, occupies the shores for between 3 and 4 miles, at the end of which distance a change takes place, and the bands exhibit alternations of very fine-grained grey gneiss, in thin and regular layers, the planes of which are covered by scales of silvery mica, together with very regularly bedded mica slates, composed of large scales of silvery mica and white quartz in thin interstratified layers. Reddish or brown garnets are plentifully distributed through the micaceous rocks. The dip, where these slaty alternations were first seen on the east side of Long Island, was due north, < about 60°, but at the small cove on the north side of the Island, near Eagle Island, they dip N. 25° W. < 15°. The precise relation that this latter gneiss bears to the former has not yet been satisfactorily ascertained, the contact at the places visited being very obscure; but judging from the attitude and distinctive qualities of the two sets of strata, it may be presumed that the formations are of different ages, and probably unconformable.

On Eagle Island a dark grey, very fine-grained sandstone comes in, conforming in dip and strike exactly with the gneiss and mica slate of the north shore of Long Island. Those sandstones are of very fine texture, and contain minute scales of mica, diffused through the rock irregularly; while passing upward on the same dip to Isle Bois, we find beds of the same quality inter-

stratified with beds of black plumbaginous or carbonaceous slate. These slates, with their included beds of sandstone, have a wide spread over the regions around the head of the Bay D'Espoir, the prevailing dip being at a low angle to the northward, or, as at Bay Rotti, occasionally horizontal. At some parts, doubtless, the same rocks are very much disturbed, and the cliffs display numerous sharp folds and corrugations, as well as repeated dislocations; but at the same time the average dip is not high, and the thickness is probably by no means excessive, though it is very difficult to determine, in consequence of the frequency of repetition. From Isle Bois these strata strike on a north-easterly course through Richard's Island and up the valley of the Little River, spreading over the region to the northward and north-west towards the head of Bay D'Espoir. The slates at some parts of their run are softer than at others, and pass into a black argillaceous shale. At Bay Rotti the surfaces of the slate are of a fibrous silky texture, smooth and glossy, soft and unctuous to the touch, black and shining, while the arenaceous beds which here are rarely over a few inches thick, and these very thinly laminated, are frequently characterised on the surfaces by long, glistening, fibrous crystals of peculiar forms, the terminal ends of which resemble the point of a fine camel-hair pencil, and multitudes of almost microscopically small garnets. At Richard's Island a great part of the rock is soft and earthy, and with this a jet-black charcoal-like plumbaginous material is associated, which has been repeatedly removed by the nearer residents, and used for polishing stoves and such like purposes. The cliffs at Conne or Crow Head rise nearly vertically to upwards of 400 feet above the sea, and exhibit a series of dislocations apparently with upthrows on the north side. The strata of these cliffs are of similar character to those of Isle Bois and Richard's Island, with perhaps a preponderance of the more silicious or arenaceous qualities; but immediately north from Conne Head, and towards the entrance into Conne Arm, the slates, with thin-bedded sandstones of Bay Rotti, are exposed, striking north-easterly up the arm. At this point some surfaces displayed a set of obscure forms, somewhat resembling fucoids, but they were by no means sufficiently distinct to be identified with any degree of certainty. The same surfaces are thickly covered by minute garnets, and small specks of mica are generally diffused through

the rock. At the Indian village of Conne a loose slab of thin-bedded sandstone was found, lithologically resembling the inter-stratified beds of Isle Bois and other parts, but without garnets, which was covered with organic remains supposed also to be fucoids. Following the strike of the measures from Conne Arm by the valley of the South-East Brook, on a course about N. 70° E. for 3 miles, an exposure is met with on the telegraph line between Conne and Little Rivers of a pale yellowish or cream-white slaty rock, which on fracture has sometimes a very pale sea-green tinge, associated with the black slates. A specimen of this rock was submitted to Mr. Hennessey for analysis, who found it to be a silicate of alumina, with traces of magnesia.

Advancing northwards towards the head of Bay D'Espoir, the measures become more altered, and at some parts are very much disturbed. The cliffs between Conne Arm and the upper bay consist for the most part of brown, grey or yellowish, thin-bedded, hard, flaggy sandstones, with divisions of black or dark grey slate; while those within the bay, on both sides, particularly on the north side, are chiefly of a hard, black or dark grey, sometimes silicious clay slate, which, from its jointed structure and cleavage, splits freely into rhomboidal prisms. Many of those appear to be of a good quality to be used as whetstones.

Quartz veins are exceedingly numerous in this formation, many of which run quite parallel with the beds for long distances, while the fissures occasioned by folds and dislocations are invariably filled with quartz, which is often charged with metalliferous ores. Of the latter, the sulphurets of copper, lead, and iron are the most frequent, disseminated in specks, isolated crystals, and patches. At Big Barbe Head, near the upper part of Bay D'Espoir, a strong quartz vein, or rather a cluster of veins, which fill up the cracks and crevices where the rocks are much contorted and broken, contain these ores in considerable abundance. The main vein, which runs upon the axis of a sharp corrugation, and is about 3 feet thick, is slightly calcareous, and in it a small leader of prill galena was struck, about half an inch thick, mixed up with carbonate of lime. Small spots of copper and iron pyrites are diffused through all the droppers and reticulating veins, as well as the main vein. A series of similar veins was observed on the point of the peninsula of the mainland opposite the western end of Isle Bois, all containing the

ores of copper and lead; and these ores are likewise indicated, more or less, at many other localities within the bay; from which circumstance it is not unreasonable to infer that possibly some locality may yet be discovered within the region where lead or copper may be worked with advantage.

Between the Bay D'Espoir and Long Pond the rock of the country is for the greater part concealed below a great accumulation of peat or forest, but on the barrens, which rise over the eastern shore of Long Pond, some slates are exposed with interstratified thin beds of quartzite or altered sandstone. These strata display a more altered appearance than those of the sea-shore. The rock when broken has a greenish cast, is of a very fine texture, and some of the harder beds have a conchoidal fracture. They weather of a dark dull brownish colour, except where fire has overrun the ground, when they assume a pale grey or whitish aspect. The surfaces and outcropping edges of the slates are wrinkled, and break into splinters. On Long Pond, black or very dark grey slates, with compact and hard dark-grey sandstones, are exposed at intervals, striking exactly with the trend of the lake from head to foot, and dipping to the westward. Very minute scales or grains of mica are diffused through these strata, and on a few surfaces of the sandstone obscure organic remains were found, supposed to be fucoids. Near the lower end of Long Pond, on the eastern side, some large angular blocks of a very crystalline rock of magnesian quality were observed, which, although differing entirely in mineral character to the rocks in place close by, seemed nevertheless, from the great size and number of the masses and their sharply angular edges, to have been transported from no great distance. On fracture these blocks are of a pale green and white, with many bright green crystals; but the exposed surfaces weather of an umber or bright reddish brown, which descends into the stone for the eighth of an inch or more. The bright green crystals appear by an analysis by Mr. Hennessey to be pyrosklerite, or a silicate of alumina and magnesia, combined with chromium. The dip of the rocks on the western side of Long Pond is usually northwesterly, the rate of inclination very variable. Near where the river enters, and up the lower reaches, it varies from being nearly vertical to almost a horizontal attitude; the bed of the stream intersecting the rocks obliquely, and the strata accumulating until

reaching the rapids at the great bend, where from the evidences obtained on the lakes above, they appear to be cut off by a great mass of granite.*

The granite then forms a great belt running in nearly a straight line, but varying in width, from the Witch-hazel Hills to the Partridge-berry Range, at the head of the Gander River, occupying the country around Soulis and Brazil Ponds; while at a little distance north-east of the latter pond, slates are again brought in. There are not many exposures above Brazil Pond, either on the river or on Little Burnt Pond, the shores and bed of the stream being mostly covered over by a great accumulation of boulders or very coarse shingle. At the rapids between these two ponds the rocks are crystalline and micaceous, in solid hard beds sometimes nearly a foot thick, on the surfaces of which rudely hexagonal prismatic crystals of staurolite were observed, of a blackish or brown colour. Boulders and fragments of a micaceous and gneissic rock, with crystals of staurolite, are profusely scattered over the shores of the lakes above, and over the surrounding country; and it was noticed that those boulders were always intermixed with fragments of serpentine and magnesian slates. On the river between Little Burnt Pond and Round Pond some of the strata are of gneissic character, consisting of fine grains of quartz and hornblende, with mica in very small scales. These gneissic beds are associated with slates and quartzite, some nacreous or chloritic strata, and a few interstratified layers which are slightly calcareous. At the falls the prevalent dip is north-west, but the strata are greatly disturbed. The cracks and fissures are lined with white quartz. At the entrance to Round Pond the dip is north, $< 60°$; but farther up, where the lake opens out above the southern arm, the dip is easterly, $< 60°$. Above this the rock is granite, mostly of a blackish grey colour, which constitutes another belt or ridge running from the White Hills in a north-easterly

* I have indicated the granite as intrusive *provisionally* only, as there is no direct evidence to show that it has had a sedimentary origin. At all the places where the rock described as granite was seen, it is *mineralogically* a true granite; but as perfectly similar rocks have frequently been found to be only massive beds of metamorphosed strata, such as at Green's Pond (see Report for 1869, p. 194), it is by no means improbable that such may be the case in this region, and that they are in reality Laurentian gneiss, brought into their present position and relation with the newer formations, on the axes of undulations, or through the agency of great dislocations.

direction, forming the islands of Round Lake, and bearing for the Partridge-berry Hills.

The north shore of Round Lake exposes strata of very hard compact quartzite in layers, varying from 1 to 7 inches thick, associated with black or dark grey silicious splintery slate dipping N. 30° W. < 63°. These are overlaid by slates, which appear to be magnesian; the colour of the rock when fresh broken has a greenish tinge, apparently from the presence of chrome, but it weathers of a reddish brown, and is very ferruginous. A ridge of this slate rises in a marsh a little way back from the left bank of the river, and strikes straight up the north-west arm, showing itself at intervals along the shore, and at the falls of the brook which runs in at its extreme western end. The rock of the country to the north and north-east of this ferruginous ridge, and between it and Newfoundland Dog Pond and River, is in a great measure concealed below a great accumulation of bog and marsh, or thickly strewn over by boulders and débris, showing itself only in a few of the more elevated peaks and hummocks, where altered rocks of a slaty structure, dark green on fracture and weathering white, are exposed in corrugated strata, reticulated by white quartz veins; but at the outlet of Newfoundland Dog Pond there is an exposure of serpentine in a band of about 30 feet thick. The strike of the serpentine here is about E.S.E. and W.N.W., with a northerly dip; but judging from the number and angular form of the fragments of that rock, on and over the banks of the stream below, it would seem to run parallel with and not far from that brook, crossing the main river near its junction with the marshy basin above Round Pond, where green chlorite slates are exposed, dipping at a high angle to the northward and striking towards the north-west angle of the basin. From the exposure at the outlet from the Newfoundland Dog Pond the serpentine in its easterly course probably strikes up the pond for a mile and a half or 2 miles, when making a sudden bend, and striking off in a westerly direction towards the outlet of the stream from Elnucheibeesh Gospen, between which and the main river it rises in the mountain chain of the Jamieson Hills; then striking almost due north to Mount Cormack, and bearing for the great Exploits River.

The whole of the Jamieson hill range is constituted of one or other of the varieties of ophiolite, described in the 'Geology of

Canada,' pp. 608–9. The stratification is distinctly marked in some cases, while in others it is obscure. The hills present a bold and sharp escarpment to the eastward; and the shores of Elnucheibeesh Gospen expose a black fibrous slate dipping towards the hills, and passing below the serpentine; between Elnucheibeesh and Pipe-stone Ponds the thickness of the strata, unless there are repetitions which it would be difficult to perceive, cannot be under and probably is over 1000 feet. The black rock at the base of the section is occasionally in compact layers of about half an inch thick, and presents a fibrous structure, at nearly right angles to the stratification. The exposed surfaces are sometimes sprinkled over by minute specks, probably garnets. The escarpment above exhibits the outcropping edges of great beds of serpentine, varying in thickness from 4 to 8 or 10 feet. Some of these massive beds are hard and finely crystalline, always of a greenish colour, but sometimes very dark; at other times they are soft and can be cut readily with a knife; while another variety is coarsely crystalline, contains pyrosklerite and diallage, and is of great specific gravity from its metalliferous contents, which appear to consist of chromic iron, magnetic iron, arsenical pyrites, and probably nickel ore. Towards the top of Sit-down Hill there is a great amount of picrolite running through the rock, which breaks out in long fibrous crystals, the surfaces of which are somewhat opalescent, usually of yellowish green, and sometimes of an approach to cobalt blue. Thin seams of asbestos with white quartz veins are also frequent. A lower ridge runs parallel with the principal hill range, and nearer Pipe-stone Pond, of a greenish-grey dolomite, rather coarsely crystalline, which effervesces feebly in acid. All these rocks weather a bright reddish brown which penetrates the rock, when long exposed, to the depth of a quarter of an inch or more, and the hills composed of them are more than usually sterile.

Immediately to the westward, and in front of the range of ophiolites, a set of silicious slates with interstratified quartzite and diorite, with heavy beds of an altered conglomerate, compose a belt of country between Pipe-stone Pond and Great Burnt Pond. A bed of conglomerate, 8 or 10 feet thick, with diorite, crosses the river about half a mile above its junction with Pipe-stone Pond, which is traceable on or near the banks of the main river, down to the turn near the end of the 3rd course, and below

the junction of the stream from Elnucheibeesh. The matrix of this band of conglomerate is finely crystalline, resembling the diorite with which it is associated; the pebbles, which are for the most part well rounded, are chiefly of quartz, with many also of granite and gneiss, and some of black slate; the latter are frequently angular.

Another bed of conglomerate, about 3 feet thick, and of similar composition to the one just described, was observed on a small islet at the extreme head of the north-west arm of Round Pond, while the northern shore of the same arm was strewed over with huge boulders of conglomerate, together with many of smaller size of serpentine and other magnesian rocks. The relation of this conglomerate with the serpentine is by no means clear; the position the 3-feet bed occupies would appear to place it below them, unless it is brought there by the agency of a dislocation, perhaps connected with the granite protrusions near by.

The distribution of erratic boulders throughout this region, appears in some cases to afford a tolerably trustworthy indication of the rock below; although such evidence cannot always implicitly be relied upon. Thus it was found that where the serpentine range sank beneath the plain, angular fragments of the rock were numerously scattered about, and with these countless numbers of micaceous boulders with staurolite of all sizes. Granite, syenite, and gneissoid boulders are perhaps the most abundant of all the erratic masses everywhere, and of the largest size; but these were usually more or less rounded, while the boulders with staurolite, and those of serpentine, were almost always angular. The staurolite rock was found most abundantly in the country between Round Pond and Newfoundland Dog Pond, where it was supposed the parent rock might outcrop, and where, assuming the dip to be northerly, it would pass below the ophiolites. On Pipe-stone Pond some fragments were found of a compact white or cream-coloured limestone, which apparently came from no great distance, although the parent bed could nowhere be discovered; and on Round Pond on the north shore some angular boulders were picked up of a pure white crystalline carbonate of lime.

On the connecting stream between Pipe-stone Pond and Great Burnt Pond, and approaching the latter, it was remarked that the loose fragments of the magnesian rocks had disappeared, and the boulders mostly or altogether were of granite and gneiss.

The many points of resemblance in the above description of the serpentine range to the rocks which constitute the Lauzon division of the Quebec group at other parts, forcibly suggests that horizon as its proper place in the geological sequence; and in common with that group its members contain metalliferous ores of various kinds of great economic value. Chromic and magnetic iron are more or less disseminated all through the formation, and lumps or masses of the former ore are strewn upon the shores of Pipe-stone Pond and in the hollows between the ridges of the Jamieson Hills, which have been removed from their original beds by disintegration of the enclosing rock, and the action of running water. Copper is occasionally indicated by the stains of the green carbonate; arsenical iron pyrites abounds; and the ores of nickel and cobalt were suspected to be present, particularly in the coarsely crystalline variety, with diallage and pyrosklerite. Unfortunately, the condition of the rocks generally is unfavourable for the preservation of organic remains, and none whatever have yet been discovered throughout the region, with the exception of the obscure forms already mentioned to have been found near Conne in the Bay D'Espoir, and on Long Pond. Assuming, however, that the ophiolites are of the age of the Lauzon division of the Quebec group, the plumbaginous and other slates, with their associated strata, would represent the Levis division, and possibly a portion of the Calciferous, the base of the whole resting directly upon Laurentian gneiss without the interposition of Primordial or Intermediate strata, which appear to terminate to the westward with Fortune Bay.

Of Primordial Silurian and Related Formations.

Rocks of Primordial Silurian age were found in detached patches occupying areas of various extent at sundry parts of the coast as far west as Fortune Bay, and upon the Island of Langlois of the Miquelon group. The spread of those rocks in Trinity, Conception, St. Mary's, and partly in Placentia Bays, with their relation to the inferior formations, has already been described in the Report of last year. At those parts the Primordial formation was found in unconformable contact with the Intermediate system, or resting directly on Laurentian gneiss; most frequently in the

former position, which also appears to be the case in its western extension. It would be premature, however, to state the age of the lower formation in the latter, as an ascertained fact, before those regions are much more extensively and thoroughly examined. Suffice it to say, then, that the Primordial Silurian of Fortune Bay rests, with one or two exceptions, upon rocks unlike in most respects to the Laurentian system, but with some characteristics peculiar to the Huronian or Intermediate; which may, until further evidence is obtained, be provisionally classed as of Huronian age. On the east side of Fortune Bay, between Point May and Grand Bank, Primordial strata were found to be underlaid by reddish altered sandstone, sometimes conglomerate or breccious passing into porphyry. These rocks were observed to strike into the country, east of Point May, and to come out upon it again north of Grand Bank, whence they occupy the coast as far to the north as Little Garnish, and probably beyond. In their south-western strike they were seen on the Island of St. Pierre, thus forming the south-eastern rim of a trough, the north-west edge of which rises on the southern part of the great Miquelon Island, and on the Island of Brunet. The Cape and northern extreme of the great Miquelon is gneiss, supposed to be of Laurentian age, while Langlois Island is of undoubted Primordial strata, corresponding with the fringe of mainland facing the sea north of Point May. The subordinate sandstones and conglomerates, at the localities just mentioned, were supposed to represent a portion of the Signal Hill rocks, probably *g* of the section in Report for 1868; but at Long Harbour, at the head of Fortune Bay, some slates were met with resembling *b* or *c* of the same section.

Much of the interior of the peninsula appears to be of felsite or feldspar porphyry, a great part of which is intrusive. Mr. Howley describes the most prominent feature of the region to consist of a range of hills, constituted of rock of that description; which coming to the sea at Cape Chapeau Rouge, bears for the isthmus which connects the peninsula with the mainland, and thence towards Sound Island and the country near Piper's Hole, in Placentia Bay.

The age of the rocks which occupy the eastern side of the Cape Chapeau Rouge range, and which take up the shores of Placentia Bay, we are still without sufficient data to establish;

yet there are some points of resemblance in lithological character, to certain members of the Quebec group, which must not be overlooked. Moreover, although there is much disturbance and confusion throughout all the region, and a regular and successive sequence nowhere to be found, there are, nevertheless, some important facts which tend to indicate a higher position to those strata than that of the Primordial. Thus it has been shown in my Report for 1868, at page 165, that while Primordial rocks are exhibited at Come-by-Chance, on the east side of North Harbour, the western shores of North Harbour and Sound Island, are talcoid or chloritic slates (which, judging from the direction of the dip, overlie the former), resembling the rocks near the horizon of the Quebec group. In the same manner small outliers of the Primordial strata have been recognised on some of the islands and points farther south, as at the entrance to Paradise Sound and on Red Island, and are suspected also to constitute a portion of the Merasheens; while at Audearn the rocks are red, green, and purple slates, and at Mortier Bay limestone is met with, interstratified with very micaceous incoherent sandstone, and conglomerate beds. At Cook's Look-out, directly north from Mortier Bay, a greenish drab-coloured talcoid or chloritic slate, resembling the Sound Island slate, flanks the hill, which is of felsite. At Burin also a mass of limestone occurs, with diorite below, and a succession of green and reddish slates with some thin calcareous strata above, which in some instances are slightly unctuous to the touch, from the presence apparently of chlorite; at others becoming arenaceous, very fragile and incoherent when exposed to the weather. These rocks abound in iron pyrites, and their decomposition seems at many parts to yield a yellowish or red ochre, by which the cliffs and rocky surfaces are frequently stained. On the coast of Burin the attitude of the strata is vertical, or nearly so, striking about east and west, but the general dip is north-west.

Assuming, then, that the formation on the east side of the peninsula is of the age of the Quebec group, the intrusion of Cape Chapeau Rouge may represent the direction of a great fault, with an upthrow on the west side, causing the repetition of the older strata at Fortune Bay.

All the above remarks must be received as merely suggestive,

for throughout this complicated region, until it is more thoroughly examined, no certainty can be arrived at, nor would it be prudent to express an opinion too confidently upon structure where so much obscurity and confusion prevail.

In consequence of the many rumours that have been circulated as to the presence of a very valuable ore of silver at Little Lawn, I directed Mr. Howley to pay special attention to that part of the coast, and to collect as many specimens of various qualities (particularly where there might happen to be metalliferous indications) as possible, in order to ascertain the facts connected with such statements, and the grounds upon which they were founded. Some years ago a specimen of this ore was presented to me by a gentleman of this place, which I afterwards put into the hands of Dr. Sterry Hunt, of the Geological Survey of Canada, for analysis, who pronounced it to be a pure sulph-arseniet of silver (ruby silver) coated with chloride of silver (horn silver), giving 65·28 per cent. of the metal. Another specimen was referred to Dr. Sterry Hunt at the same time, of lead ore said to have been derived from the same place as the silver ore; in which, however, no appreciable trace of silver was discovered. The gangue of the latter was green fluor spar.

Mr. Howley describes the country around Lawn as consisting almost entirely of reddish felsite or feldspar porphyry, with occasional broken and shattered masses of stratified rock, sometimes occupying an area of about an acre, but more usually less, and at other times in great fragments caught in and surrounded by the igneous or intrusive rock. These stratified fragmentary patches are of black slate, containing numerous nodules of iron pyrites, dull white and reddish limestone, red and green slate, all of which have a Primordial aspect, but are apparently destitute of fossils. On the east side of Little Lawn Harbour, Mr. Howley found an opening about 30 feet above the water, 8 feet high by 4 wide, which had been driven into the cliff for about 30 yards. The design of this opening appears to have been, to follow a vein of fluor spar containing galena and zinc blende, with the expectation of striking the silver ore; but failing to find the latter, and the lead and zinc being apparently insufficient in quantity to be remunerative, the place was abandoned.

The main vein of fluor spar, with its metalliferous contents,

runs in a fissure which intersects greenish slate and porphyry, bearing in a tolerably straight course through both about south-east; while smaller veins of the same mineral character are ramified or reticulated from it on either side. The fluor spar is arranged in the crevices which contain it, in isolated detached masses of various sizes, the interstices between which are filled up with crushed débris, derived from the rocks on either side. These masses are sometimes of considerable size, being upwards of a foot in length, with the whole width of the fissure, and present a foliated or lamellar structure upon being broken, in layers of different shades of green and white; others are small and concretionary, the concretions formed of a series of concentric layers of the same colours. In either case, the centre part is always of the darkest shade, and is a bright sea-green, while the outer layers become paler in colour towards the exterior surfaces which are white. It was found, with few exceptions, that the zinc ores were almost exclusively disseminated in the middle or darker green parts, while the galena was distributed along with and parallel to the external layers. The width of the main crevice varies from 6 to 2 inches. The walls are polished and furrowed.

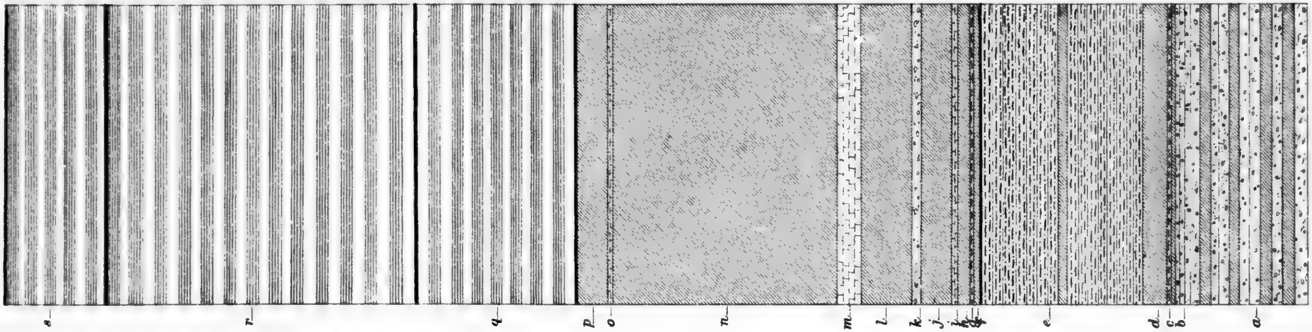
Several specimens from this locality, selected from a large collection made there, and now deposited in this Office, were submitted to Mr. Hennessey for analysis, whose results prove the existence of bismuth * and cadmium to be combined in traces with the ores of lead; and of cadmium and iron with those of zinc; but in no case any trace of silver. This circumstance is remarkable, as the ores of lead are frequently, if not most usually, more or less argentiferous; and, moreover, it may be observed, that notwithstanding a most careful search having been made over the ground by Mr. Howley, he failed to perceive the smallest remnant of any substance bearing a resemblance to the precious ore.

Primordial Silurian Formation.

At page 157 of the Report for 1868, a section of this formation is given, as exhibited in Conception Bay, showing an accumulation

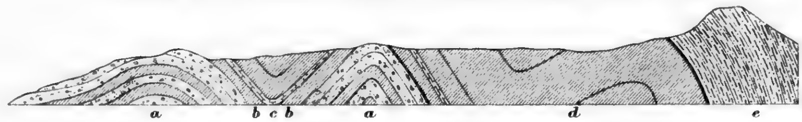
* This valuable metal is used for various purposes as an alloy. With tin and mercury in about equal proportions it forms *mosaic gold*. With certain proportions of tin and lead plumbers' solder is manufactured, and stereotype plates are cast. It is also the base of a cosmetic known as *pearl powder*.

Column of Silurian—Primordial Strata—Scale 80 Feet to One Inch.



I.

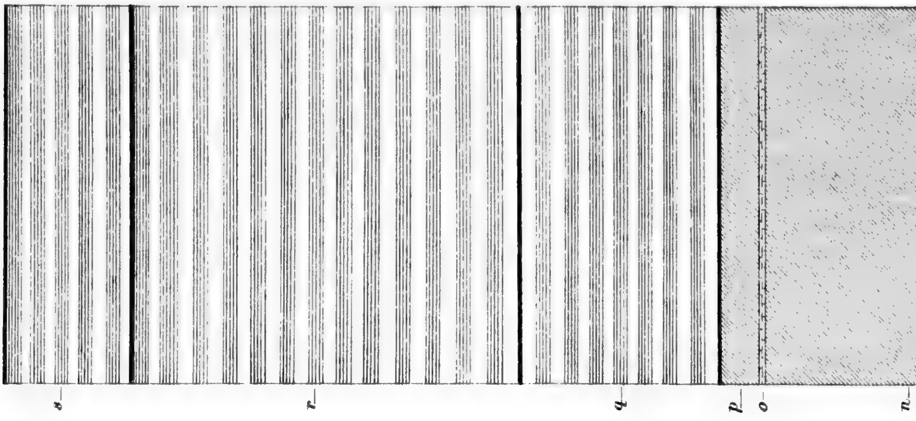
Section of the Slate Quarries, Smith's Sound, Trinity Bay.



Horizontal and vertical scale, 400 feet to one inch.

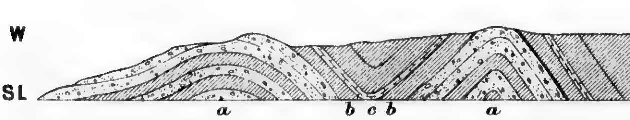
C, unconformable conglomerate; e, f, g, h, i, j, Primordial Silurian. (See p. 236). G, Granite. SL, *sea level.* N, S, *north and south.*

COLUMN OF SILURIAN—PRIMORDIAL STRATA—



I.

SECTION OF THE SLATE QUARRIES, SMIT



Horizontal and vertical scale, 400
a,b,c,d,e, Primordial Silurian. (See p.236) SL, *sea*

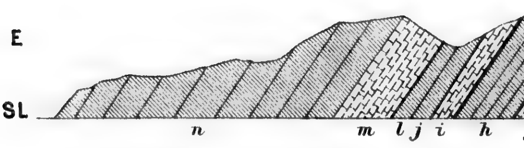
II.

SECTION NEAR THE MOUTH OF LITTLE SALMO

Horizontal and vertical scale, 200
e, f, g, h, i, j, l, m, n, Primordial Silurian (See p.236) S

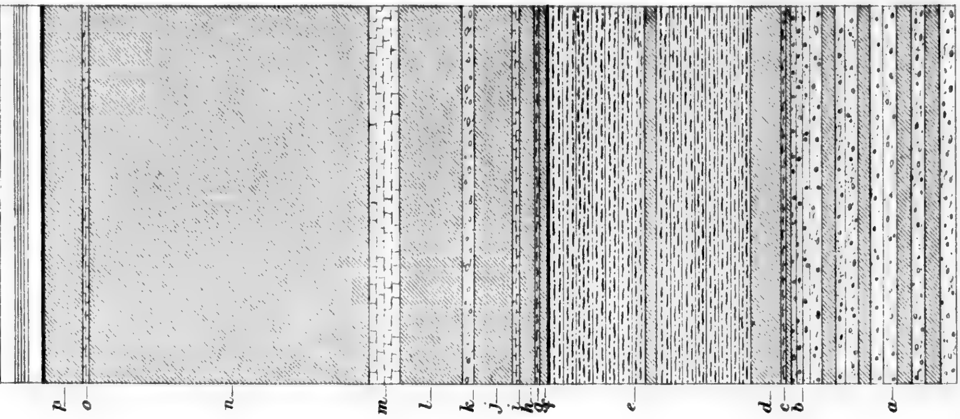
III.

SECTION AT SOUTH HEAD OF BRIGU



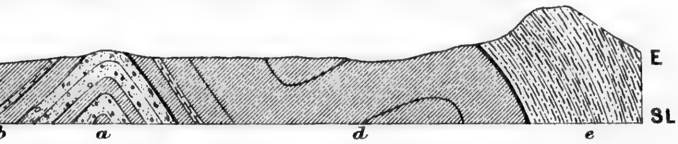
Horizontal and vertical scale, 400
f, g, h, i, j, l, m, n, Primordial Silurian. (See p.236) H. Huronia

RIMORDIAL STRATA—SCALE 80 FEET TO ONE INCH.



I.

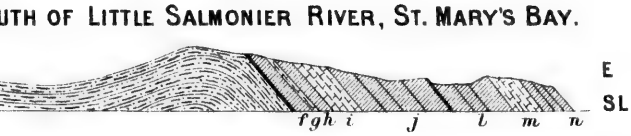
ATE QUARRIES, SMITH'S SOUND, TRINITY BAY.



and vertical scale, 400 feet to one inch.
lurian. (See p.236). SL, *sea level.* E.W, *east and west.*

II.

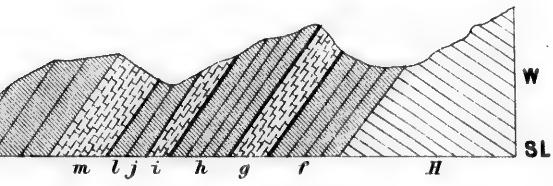
UTH OF LITTLE SALMONIER RIVER, ST. MARY'S BAY.



and vertical scale, 200 feet to one inch.
ial Silurian (See p.236). SL, *sea level.* E.W, *east and west.*

III.

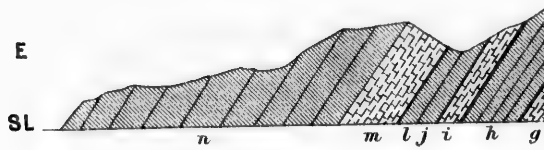
UTH HEAD OF BRIGUS, CONCEPTION BAY.



l and vertical scale, 400 feet to one inch
ian. (See p.236). H. Huronian. SL, *sea level.* E.W, *east and west.*

III.

Section at South Head of Brigus

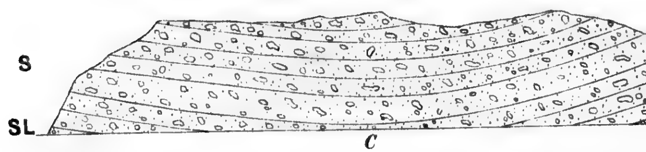


Horizontal and vertical scale, 400 f

f, g, h, i, j, l, m, n. Primordial Silurian. (See p. 236) H. Huronian

IV.

Section at Blue Pinion Head



Horizontal and vertical scale, 100

C, unconformable conglomerate; e, f, Primordial Silurian. (See

V.

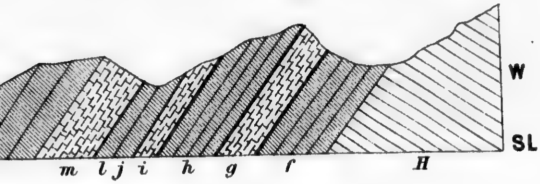
Section near the Mouth of Salmon River, He

Horizontal and vertical scale, 80

C, unconformable conglomerate; e, f, g, h, i, j, Primordial Silurian. (See

III.

TH HEAD OF BRIGUS, CONCEPTION BAY.

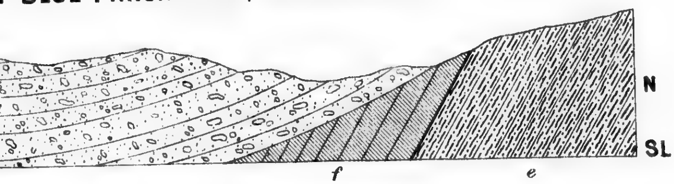


and vertical scale, 400 feet to one inch

an. (See p.236) H. Huronian. SL, *sea level.* E, W, *east and west.*

IV.

T BLUE PINION HEAD, FORTUNE BAY.

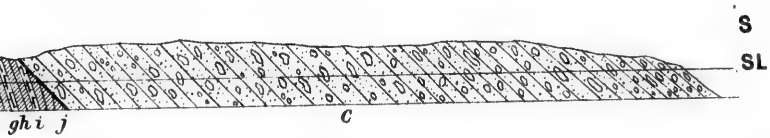


and vertical scale, 100 feet to one inch.

mordial Silurian. (See p.236). SL, *sea level.* N, S, *north and south.*

V.

F SALMON RIVER, HEAD OF BELLE BAY, FORTUNE BAY.



and vertical scale, 800 feet to one inch.

imordial Silurian. (See p.236). G, Granite. SL, *sea level.* N, S, *north and south.*

of strata amounting to 3880 feet. Since the date of that Report, it has been discovered that the formation is widely distributed at other parts of the country, in greater volume than in Conception Bay, or displaying portions which in that bay are either concealed below its waters, or altogether absent. The whole accumulation, were it found consecutively at any one place, would, by such additional strata, apparently swell the volume to a thickness not under 6000 feet.

The annexed column represents the order of sequence and superposition of the different members of the formation, with their approximate thickness, so far as has hitherto been ascertained. It may be observed that there is a discrepancy between the superposition, as given in this column, and the section given at pages 200 and 201 of last year's Report, in which the workable slates are placed as No. 5, or directly below the strata of Bell Island. The more careful examination of the late season has unravelled some of the difficult complications which led to this error the previous year, and seems clearly to place the workable slates as shown in the column, or about the horizon of No. 2 of Report for 1869.

DESCENDING ORDER.

	Feet.
s. Brown and black micaceous shales, with grey micaceous sandstones of Bell Island, Conception Bay. Organic contents are: two species of *Lingula,* four species of *Palæophycus, Eophyton Linnæanum* (Torrell) and another *Eophyton. Cruziana semiplicata* (Salter), and some others. *Cone-in-Cone* is also frequently met with. Exposed also at Random Sound, Trinity Bay, and in smaller volume at the southern part of the peninsula of Cape St. Mary	476
r. Red and green sandstones and slates, with some calcareous beds at the base, partially seen at Little Belle Island, Conception Bay, but for the greater part concealed below the water. Estimated thickness	1426
q. Kelly's Island sandstones and shales, given in detail in Report for 1868, p. 28. A few fucoids were the only fossils observed in this division.* Thickness	720
p. Black slate or shale. At Fortune Harbour this division was found to contain *Paradoxides Bennettii.* Thickness	150

* Many fossils have been found about the middle part of the Kelly's Island section since, among which *Cruziana* and two or three species of *Lingula* occur.

		Feet.
o.	A bed of dark grey limestone. Fossils consist of broken fragments of trilobites and shells, among which latter a *Lingula* was observed. Thickness	5
n.	Red, green, and black slates, or shales, which occasionally pass into a finely laminated argillaceous shale, as at Topsail Head. This division is exhibited at Branch, and many parts of St. Mary's Bay, and also at Fortune Harbour and Langlois Island. The fossils are *Paradoxides Bennettii*, *Conocephalites gregarius*, and probably some other species not yet recognised. This division abounds in trilobites which are often greatly distorted and cut up by the cleavage, which is transverse to the bedding. Thickness	1045
m.	Hard thick beds of grey and sometimes reddish limestone of Topsail Head, seen also near Brigus South Head, Conception Bay, and at Little Salmonier River, St. Mary's Bay. The supposed equivalent was likewise found in Smith's Sound, Trinity Bay. The fossils are usually obscure, and in a fragmentary state. Two species of *Conocephalites* have been recognised by Mr. Billings, and a small fragment supposed of *Paradoxides* from a loose stone found at Topsail Head; also *Salterella* and *Crania Labradorica*. Thickness at Topsail Head	100
l.	Red, green, and blackish argillaceous slates. This division is seen at Brigus South Head, at Little Salmonier, and at Random and Smith's Sound. It is seen also at some parts of Fortune Bay. A margin of the shore west of Manuel's Brook, Conception Bay, exposes the upper part occasionally; a few remains of trilobites were found at Random Island, one of which resembles *Bathyrus gregarius* (Billings). Thickness	250
k.	Conglomerate of Manuel's Brook, not recognised elsewhere. Thickness	50
j.	Red and green argillaceous shales or slates. Thickness, Brigus South Head	150
* *i.*	Red and flesh-coloured limestones, in which some obscure fossils have been found, and an *Archeocyathus* detected by Mr. Billings. Thickness..	20
* *h.*	Red slate	30
* *g.*	Thin bed of impure red limestone	10
* *f.*	Red slate	40
e.	Red, green, and grey sandstones, with occasional beds of conglomerate. The upper beds flaggy. Towards the base the beds are compact, and vary in thickness from 1 to 3 feet. The lower strata pass into a whitish, sometimes tinged pinkish quartzite. On some of the surfaces obscure forms supposed to be fucoids were found, and peculiar mark-	

* These strata are met with at Distress, St. Mary's Bay, Little Salmonier River, Brigus Head, and Random Island.

		Feet.
	ings resembling annelid tracks, seen on the east end of Random Island, and the mainland between it and Bay Bulls' Arm; and also on the southern part of the peninsula of Cape St. Mary's. Probable thickness, about	750
d.	Green and reddish-brown or purple slates, with smooth and regularly parallel cleavage, independent of the bedding, splitting into slabs under half an inch thick. This is the position of the workable slates of Smith's Sound and Random Island. Thickness	137
c.	A bed of impure flesh-coloured limestone	3
b.	Green slate, same character as *d*	10
a.	Hard, dark greenish-grey sandstones with slaty divisions, the sandstone beds varying in thickness from 4 inches to 1 foot. This part of the formation has only been seen in Trinity Bay, and the thickness at Random Island and Smith's Sound was estimated to be about	600
	Total	5972

It will be seen that the lower measures (*a*) of the section, so largely represented in Trinity Bay, and also the superior strata below (*j*), which is partially recognised in the St. Mary's peninsula, are nearly altogether wanting in Conception Bay; and, moreover, it may be remarked that the junction of the sandstones at the base of the series with the rocks of the Intermediate system (between which there is a considerable lithological resemblance) has nowhere been clearly made out; still, the evidence taken at the several localities where the formation is displayed, goes strongly in support of the structure being in reality as given in the column. In Trinity Bay the section, although affected by disturbances, seems to be nearly complete, while on the St. Mary's peninsula the strata between *d* and the upper part of *n*, inclusive, are found in conformable succession. At Brigus and at Harbour Main, in Conception Bay, some beds of red sandstones, representing the upper part of *e*, were found at the base of the group, overlaid by slates and limestone representing *f*, *g*, *h*, *i*, &c.; the lower strata of which come unconformably in juxtaposition with the corrugated rocks of the Intermediate system, and dip in the opposite direction. The absence of the lower members in Conception Bay must, therefore, be accounted for, by supposing a subsidence to have taken place in that region subsequent to the deposit of the earlier sediments of Trinity and St. Mary's Bays. The Primordial patches of Fortune

Bay seem also to have begun at a later date than those of Trinity and St. Mary's Bays, as no part of the column lower than *e* is anywhere recognised in that region.

The diagram, Section No. 1, illustrates the arrangement of the lower measures, with corrugations resulting from disturbance, as displayed at the slate quarries, Smith's Sound, Trinity Bay.

Section No. 2 shows the order of succession, as seen at Little Salmonier, St. Mary's Bay.

Section No. 3 represents the unconformable junction of the Primordial rocks with the contorted strata of the Intermediate system; and the succession of the former as exhibited at the south head of Brigus, Conception Bay.

On the coast of Fortune Bay, between Point May and Grand Bank, the strata of Primordial age are represented by the members of the column between *e* and *s*, inclusive. At Little Dantzic, the lowest strata appear to belong to division *e*, while the measures accumulate advancing northwards and near Fortune divisions *n*, *o*, *p*, and part of *q*, were recognised by their organic contents as well as by their lithological character. Still higher measures come in approaching Grand Bank, where the fossils have a general resemblance to those prevalent in division *s* of the Bell Island group.

On Langlois Island part of division *e* was recognised, which appeared to be immediately overlaid conformably by the upper part of *n*, the latter containing trilobites, mostly *Paradoxides*. The absence of the Intermediate divisions, between *e* and *n*, together with the greatly reduced volume of the formation on the coast of Fortune Bay, seem to indicate a gradual thinning out in its western extension, which probably terminates with the Miquelon outcrop.

The Section No. 5 is given to illustrate an exposure at the mouth of the Salmon River, which flows into North Bay, the extreme northern inlet of Fortune Bay. In this section an intrusive mass of granite is represented overturning a set of stratified rocks, which latter, after exhibiting a series of sharp flexures, pass unconformably beneath a conglomerate. The contorted strata, which comes against the granite, was supposed to be the equivalent of *f* of the column, and is succeeded by two beds of limestone representing *g* and *i*, which are repeated by means of the folds,

bringing up portions of *e* on the anticlinal axes. As no fossils were found in these rocks, their true horizon is still a matter of uncertainty; although lithologically and in stratigraphical sequence the resemblance to the divisions indicated is strikingly suggestive. There is no evidence whatever by which the precise age of the overlying conglomerate can be determined. The matrix of the rock consists of a rather coarse silicious paste of a pale greenish colour, in which are imbedded boulders and pebbles, mostly rounded, of granite, gneiss, and quartzite, ruins of the rocks of the surrounding country. The lower strata of this conglomerate are very coarse, often containing boulders of 2 feet and upwards in diameter, which are usually of granite and gneiss.

Section No. 4 represents a mass of conglomerate resting unconformably upon some red and green slate, which is underlaid by whitish and pale grey quartzite in beds of from 1 inch to 18 inches thick. Lithologically the latter beds resemble the strata frequently met with at the top of division *e*, their supposed equivalents. The upper beds which come in contact with the conglomerate were supposed to be about the horizon of *f*. There does not appear to be any reason to doubt that this conglomerate is an extension of that seen at Salmon River. The section is exposed at a place called Blue Pinion, between English Harbour and St. Jacques Harbour, on the north shore of Fortune Bay.

A conglomerate, supposed to be of the same horizon as that represented in the above sections, is exhibited at St. John's Head, another point on the north side of Fortune Bay, which was alluded to in a preceding page of this Report, as coming against an intrusion of porphyry, the latter dividing it from the gneiss of the country inland. The general character of the conglomerate of this place is much the same as that already described, with this difference, however, that the matrix was found in some instances to be slightly calcareous, and that among the pebbles, some were of a brownish-red sandstone, seemingly derived from the Primordial rocks, and others of micaceous and black slate, the latter strikingly resembling the plumbaginous slates of Bay D'Espoir.

INTRUSIVE ROCKS.

In the foregoing pages of this Report allusion has frequently been made to the occurrence of eruptive or intrusive masses intersecting the stratified or sedimentary formations. The mineral character of those intersecting masses is various; and in some cases different mineral qualities pass from one into the other in the same intersection. The Primordial rocks of the St. Mary's peninsula are divided by great masses of trap from Bull Island Point and Point Lance to the Sawyer's Hills, which probably extend uninterruptedly to Trinity Bay. At the south end the rock is greenstone, more or less compact, which in its course northwards, passes into porphyry and amygdaloid, as at Sawyer's Hills. At Chapel Arm, in Trinity Bay, the trap is vesicular and amygdaloidal, the cavities usually filled with white calc spar. Dykes of dark green or black greenstone also intersect the strata, running oblique or at right angles to the great north and south masses, many of which may be seen upon the coast, both on the St. Mary's and Placentia sides; particularly near Branch in the former, and the neighbourhood of Distress in the latter. It has already been stated that a great part of the peninsula between Placentia and Fortune Bay consists of felsite or feldspar porphyry. Although the mineral character of the rocks generally throughout that region is for the most part tolerably uniform, intersections can be clearly distinguished at some parts cutting across and ramifying through the surrounding masses; thus a great proportion of the latter, although without any clearly defined structural arrangement or evidences of stratification, may, nevertheless, be an indigenous sedimentary deposit. The great Chapeau Rouge mass, which, at its southern extreme, is a porphyry, is probably connected with the dislocation observed at Sound Island and Black River, at the head of Placentia Bay, where the intersecting rock is granite. Some small intrusions of a red feldspar porphyry were observed to cut Primordial strata at Random Island and Random Sound, Trinity Bay, and at Cape Dog in St. Mary's Bay. The intersections of Langlois Island and the east shore of Fortune Bay were found in every case to be of greenstone; but at St. John's Head the conglomerate, which at present is supposed to be of more recent date than Primordial, seems to have been broken through at its junction with the gneiss, by a dyke of

feldspar porphyry, about 20 feet wide. The trap at Langlois is nearly a quarter of a mile across; but the dykes between Little Dantzic and Fortune Harbour are rarely over 3 or 4 feet thick.

The intrusive and metamorphic rocks of this region require a much more rigid and close examination than time or opportunity has hitherto permitted to be bestowed upon them, and many carefully arranged specimens must be submitted to chemical analysis, before a full and comprehensive history of their sundry characteristics can judiciously be entered upon.

Another matter of much interest relates to glacial action, and the distribution of boulders, upon which we are gradually accumulating information; on a future occasion, when more evidences are obtained, the subject will be duly reported upon; but in the meantime, for various reasons, I have deemed it more expedient that it should be postponed.

Economic Materials.

Although many rumours have been circulated from time to time of the discovery of the precious metals at various parts of this Island, I have never yet seen any further *direct* evidence of the presence, either of gold or silver, than mere traces of those metals, found by analysis in some specimens procured by myself from the Bay of Islands, on the one hand, and from Bonavista Bay on the other. In my Report for 1868, p. 167, under the head of Gold, I suggested the probability that further investigation of the gold rocks of Nova Scotia might eventually prove them to be of contemporaneous origin with the Intermediate system of Avalon, the suggestion being founded altogether upon lithological resemblances. Since the date of that Report, many important discoveries have been made in various parts of Canada and in Nova Scotia, which begin to throw some light upon a subject which at that time was exceedingly obscure; and the evidences obtained up to the present time, by Professor Hind and the officers of the Geological Survey of Canada, seem to point to a more recent period than the Intermediate or Huronian as the horizon of the auriferous strata. Professor Hind (who has long laboured in the gold districts) has always contended that the auriferous rocks of Nova Scotia were for the greater part of Lower Silurian age, and the recent discovery of

fossils within the region seems to confirm that opinion; although I am not aware as yet that these fossils have been sufficiently identified as types of a specific horizon to establish their true stratigraphical position in the Lower Silurian system. Should they eventually prove to be of Primordial age (which seems at least to be probable), or should they, indeed, be the equivalents of any of the lower divisions of the Lower Silurian system up to and inclusive of the Quebec group, it will be clear, from what I have said in this and in former Reports, that these formations are all extensively developed in Newfoundland. Gold, however, does not appear to have originated exclusively at any one particular geological period, although in some prominent cases its distribution seems to be confined to certain zones. Mr. Henry Vennor, of the Geological Survey of Canada, has traced an auriferous zone over a great area in the province of Ontario, the geological horizon of which he places near the summit of the lower Laurentian series, in close proximity to the great ferriferous belt and crystalline limestone,* while Professor Hind, who places the gold-bearing rocks of Nova Scotia as Lower Silurian, says, in his Report on the Gold Districts for 1870, regarding the origin of the metal:—"I consider that all the evidence hitherto accumulated in Nova Scotia, tends to show that the gold was originally deposited from oceanic waters, and diffused through their sediments, especially in beds of quartz. Much of it was no doubt subsequently concentrated in intercalated beds of quartz, and some instances in fissure veins." The same author points also to the occurrence of gold in more recent formations of Nova Scotia, as high as the Carboniferous. For further information on the sources and distribution of gold, I beg to refer to page 519 of the 'Geology of Canada,' 1863.

At a previous part of this Report mention has been made of the presence of the ores of lead and copper in the Bay D'Espoir, disseminated in quartz veins. From the frequency of their occurrence it is not unreasonable to infer that some part of the region may yet disclose one or the other of these ores in workable quantity, although heretofore no exposure that has been examined was found to be sufficiently encouraging in appearance to justify a recommendation of costly experiment with the prospect of a favourable result. A black plumbaginous material is also found in the

* See my Report, 1868, p. 143.

slates of the same region; but we have nowhere hitherto seen it in sufficient volume to be of commercial value. It may indeed, with considerable confidence, be presumed that the most important metal-bearing rocks are of later date than the slates of Bay D'Espoir, and are on or near the horizon of the serpentines, which have been shown to be extensively distributed over the interior. I have often in previous Reports alluded to the serpentines of the Quebec group as being in all probability the geological horizon in which the more valuable metalliferous ores would eventually be developed; in other words, that it would prove to be, as elsewhere, the great metalliferous zone of this Island; and the experience of last season has in no degree altered those views, while many facts were observed in confirmation of them. Among the most prominent and important of the ores observed in the magnesian rocks of the interior was chromic iron, which was found to be present more or less wherever these rocks were exposed; either generally disseminated through the matrix, or occurring in small boulders or pebbles scattered along the surface of the ground, near the parent beds from which they have been derived. This chromic iron ore was very frequently found to be associated with magnetic iron and arsenical iron pyrites. The presence of copper is occasionally indicated by stains of the green or blue carbonates; and the presence of nickel, cobalt, and other ores, which usually accompany the rocks of the group, although not yet actually proved by chemical experiment, may be fairly inferred. In order to show the value of chromic iron alone, and the uses to which it is applied, the following paragraph is quoted from the 'Geology of Canada,' 1863, p. 749:—

"The compound of chromium chiefly used in the arts is the combination of chromic acid with potash, known as the bichromate of potash, from which are prepared both red and yellow chromates of lead, the latter being the pigment known as chrome yellow. The green oxyd of chromium is also prepared from this salt, and is used as an indelible green colour in painting, and for the preparation of indestructible green printing ink. Large quantities of the bichromate of potash are used in dyeing, and in calico-printing; and, according to the Report above cited, the quantity of this salt manufactured weekly in South Lancashire was, in 1861, 14 tons. This salt consists of one equivalent or 47 parts of potash, and two

equivalents or 102 parts of chromic acid. Of this latter 51 parts correspond to 39 parts of the green or sesquioxyd of chrome; and although the metal exists in this latter form in the ores, it is now usual for commercial purposes to give the percentage of chromic acid which these will yield. Thus the chromic iron from Bolton, which gives by analysis 45·9 per cent. of oxyd of chromium, would yield 60 per cent. of chromic acid. Rich ores of this kind are said to be worth in Baltimore, from whence large quantities are shipped, one dollar per ton, for each unit of chromic acid. This agrees closely with the price offered for the chromic iron from Ham, to be noticed below. Samples of two barrels from this locality, sent to Glasgow and London in 1861, gave from 43·7 to 44·1 per cent. of oxyd of chrome. The mean of these, 43·9, equals 57·4 per cent. of chromic acid; and the prices offered for this ore in London and in Glasgow were respectively 11*l.* 10*s.* and 12*l.* sterling per ton."

The remote geographical position of the serpentines of the Bay East River may certainly be unfavourable to the early development of their mineral contents; yet should the formation in its northern extension reach the valley of the Great Exploits River, as our present evidence shows to be probable, which river is said to be at all times navigable for canoes, it may then be sufficiently convenient to the coast for (at all events) partial experiment; and in this connection I think it highly desirable that a survey of the principal river in Newfoundland should be made as soon as circumstances will permit. I was informed, moreover, by one of the Indians, that about 10 miles below the part where we reached the Gander River, or about 30 above Gander Lake, he had crossed some rock which he regarded as pipe-stone, or the same quality as that of the Jamieson Hills. If such is the fact, there is little doubt it is a repetition of the same formation, probably on the eastern flank of an anticlinal axis; to take up which outcrop and trace it through the country on either side, would, beyond doubt, be of very great service in revealing the structure of the country in general, and the geographical distribution of the metalliferous group in particular.

It must have occurred to any one who has conversed upon the subject of the mineral resources or economics of the country, how prevalent the idea is, that these terms exclusively apply to the development of metals, or metalliferous ores; while many other

materials of humbler pretensions, although in reality of greater importance to the general welfare of a rising community, are ignored as valueless or of little account. The glittering prospect of suddenly realising wealth which metallic indications, particularly of the precious metals, are almost sure to induce, is but too frequently attended by disappointment, and often by irretrievable loss; whereas many more ordinary natural productions may by proper attention be extracted from their beds without risk of failure. Mining for metals must, under the most favourable circumstances, be attended with vast expense, and always with more or less hazard. The success or otherwise of quarrying for the rougher materials, such as gypsum, limestone, building stone, whetstone or slates, may be calculated with accuracy at the outset, upon the usual commercial principles of demand and supply.

Foremost amongst these latter materials, roofing slates may be placed as a natural production of this Island. Judging from the quality of the specimens which were brought from Smith's Sound, and are now in this collection, and the thickness of strata attributed to their place in the formation, together with their proximity to the sea, these slates when fully developed can hardly fail to prove of very considerable commercial importance.

In consequence of the very limited demand (which hitherto has been entirely local), the slate quarries at Smith's Sound and Random Island do not appear so far to have proved remunerative, and the work, proceeding spasmodically at intervals, has been carried on to only a small extent; but as the tendency is constantly gaining ground in all the great cities of the continent of America, dictated by prudence and economy, to substitute slates for the old-fashioned perishable and inflammable shingles, it may reasonably be expected that a market for the article will soon be found, and a profitable return ensured for enterprise in its production upon a large scale.

By reference to the column given of the Primordial Silurian rocks, it will be seen that the stratigraphical position of the workable slates is indicated by *d*. This part of the formation has been recognised on both sides of Random Island, on the south side of Random Sound, and at Bay Bulls' Arm.

It probably also, judging from the strike of the measures, will

be found at other places in the interval between the two latter places, particularly in the neighbourhood of St. Jones and Deer Harbours. But while the horizon of the slates may be better developed in Trinity Bay than elsewhere, it is not limited altogether to that region. At Keels, in Bonavista Bay, an outcrop is reported; and the red slates westward of Gooseberry Cove, in Placentia Bay, are now supposed to be their equivalents. Furthermore, I perceive, by my field-notes of 1866, in describing the coast of Avalon, it is remarked that "a change of formation was observed to take place in the neighbourhood of Ferryland, and that at Renews there were found to be large masses of red slate strewn over the ground, apparently not far removed from their original position, which had a smooth and perfectly regular cleavage, nearly at right angles to the plane of the bedding." This part of the country has not yet been examined, but the circumstance just mentioned, together with the accounts of some of the residents, give reason to suppose that an outlying patch of the formation is to be found there, and with it some portion of the workable slates.*

At page 178 of my Report for 1868, mention is made of a slate of economic value occurring near Brigus, in the older or Intermediate system, which, although doubtless a very serviceable material for many economic purposes, is, nevertheless, of inferior quality as a roofing slate to those of the higher formation. The cleavage of the former is less perfect, it splits less finely, and consequently is heavier, and it is more or less affected by rectangular joints, which necessarily limit the surfaces.

Limestone is another substance which must be universally admitted as an indispensable necessary wherever a dwelling of any description is to be erected. Beds of limestone, as our column has shown, are abundant in the Primordial Silurian formation, especially among the middle and upper members, and it is perhaps owing to the calcareous quality of these strata that the superior quality of the soil over the areas they occupy is especially to be attributed. Besides the ordinary uses, such as for building and burning, the limestones of the formation are suitable in many cases for ornamental purposes as a marble.

It would be superfluous in the meantime to enter into further

* These have since been proved to be of Intermediate or Huronian age.

detail regarding other economic materials, which have been repeatedly mentioned in former Reports. The position, uses, mineral qualities, and all other particulars of such, will, I trust, in course of time find their proper places in the pages of a condensed report of the whole subject.

A tracing from the manuscript map of the region surveyed, upon a scale of 4 statute miles to 1 inch, accompanies this Report, which, together with the illustrations introduced with the text, are requisite for its elucidation. These, with permission, I shall order to be cut, the former on stone, the latter on wood, to illustrate the report in pamphlet form, which will be published hereafter.

With very much respect, I beg to subscribe myself,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

To His Excellency Col. Hill, C.B.,
Governor of Newfoundland, &c. &c. &c.,
St. John's.

CHAPTER XI.

REPORT FOR 1871.—SURVEY OF EXPLOITS RIVER AND RED INDIAN LAKE—MR. HOWLEY'S EXAMINATION OF THE COAST OF EXPLOITS BAY, GANDER BAY, &c.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, NEWFOUNDLAND, 1872.

MAY IT PLEASE YOUR EXCELLENCY,—

The investigations of the Geological Survey, during the past year, have been directed to the examination of the regions around the great Bay of Notre Dame, and more particularly to the Bay and River of Exploits, the latter of which was carefully surveyed; and I now have the honour to submit the following Report of progress, for the information of your Excellency and the Legislature.

Being provided with a vessel and crew for the coastal service, and with canoes for the ascent of the river, I proceeded, with Mr. J. P. Howley as my assistant and a party of Indians, to Twillingate, in the early part of July.

After having made a partial examination of the coast near Twillingate, and of New World Island, in order to ascertain the geological structure and probable succession of the formations distributed over that region, I left Mr. Howley with the vessel to continue the examination of the coast, while I surveyed the River and Valley of Exploits.

In the present Report geological detail is not particularly entered into, as the subject requires being studied out with great care in all its bearings previously to giving it publicity; and for that purpose, as I had the honour to inform your Excellency in my communication of the 4th January last, a map is now being constructed upon a scale of 4 miles to 1 inch, on which it may be rendered intelligible, and from which I hope, during the present year, to be enabled to produce a condensed general

description of all that has been ascertained since the survey commenced.

A great addition was made during the season to the collection of illustrative rocks, minerals, and fossils, which, when properly arranged in the museum, will be found not only of the highest value for geological reference, but also as a means of directly affording information to persons interested in the production of various economic materials, or to those desirous of enlightenment on geological subjects.

Geographical Description of the Bay and River of Exploits.

The Bay of Exploits, properly so called, forms a deep bight on the south coast of the great Bay of Notre Dame, between North Head on the west, and Farewell Harbour at the entrance to Dildo Run, on the east. It is deeply indented by numerous arms, and inlets, creeks, and coves, of which the greatest is the inlet leading to the entrance of the Exploits River. Within the area encompassed by the shores of the bay, there are innumerable islands of various sizes, of which New World Island is the largest, which, with the islands of Twillingate, Black Island, and Exploits Burnt Island, also of large size, strike across the entrance of the Bay of Exploits, forming a barrier or breakwater to the sea on the north, and facing the Bay of Notre Dame. Exploits Burnt Island is the most westerly of those islands, and between it and North Head is the main channel of approach to the bay within, and to the Exploits River. There is also an approach from the eastward of New World Island by the Dildo Run, but the navigable channel of that passage being exceedingly narrow, and its intricacies being very great, from the numerous islands and rocks with which it is crowded, it is rarely frequented, except by boats or craft of small size and light draught of water.

Exploits Burnt Island is situated in lat. 49° 30′ N., and long. 55° 4′ W., and from it the general course of the main channel is a little to the westward of south from the true meridian, to the entrance of the Exploits River. In following up the channel, several large islands are passed, the chief of which is Thwart

Island, on the eastern side; but the water is deep all along, and there is no impediment to the navigation, for vessels of any size, until reaching Peter's Arm, where there is good anchorage. Opposite the northern end of Thwart Island, a narrow isthmus of only about half a mile across separates the Bay of Exploits from New Bay, the extension of which to the north forms the great promontory terminating at New Bay Head and North Head.

The entrance to the Exploits River is at Wigwam Point, in lat. 49° 5′ N., long. 55° 19′ W., nearly at the south-western extreme of the long arm already indicated. Immediately opposite this entrance is Norris Arm, stretching for about 6 miles a little north of east, with an average width rarely exceeding half a mile, at the head of which another considerable stream falls in from the eastward.

Taking its rise near the south-western angle of the Island, and within a moderate distance of St. George's Bay, this magnificent river, with its numerous tributaries, drains an area of probably little under 3000 square miles.* The large lake mentioned by Cormack, and named by that intrepid traveller "King George the Fourth's Lake," is said to be on its waters, and to be accessible by canoes by the river's course, although with many portages. As in our expedition, however, we were unable to proceed beyond the Red Indian Lake, in consequence of the dilapidated state of our canoes when we reached its upper extreme, the upper part of the river remains still unexplored, and little dependence can be put upon the description given by the Indians. The upper extreme of the Red Indian Lake is in lat. 48° 32′ 30″ N., long. 57° 9′ W. The tabular arrangement of the courses, distances, and rise on the ascent of the river from Wigwam or Sandy Point to the head of the lake, given below, may be found convenient as reference in connection with the following description.†

* Probably nearer 4000 square miles, as shown by Mr. Howley's Survey of 1875 of the upper waters.

† The courses and all bearings are given from the true meridian.

TABLE OF COURSES ASCENDING THE RIVER AND LAKE.

No.	Courses.	Distances.		Rise in Feet.	Total rise over High-water Mark.	Remarks, &c.
		mls.	chns.			
1	S. 57° W.	5	40	..	Tide-water.	From Wigwam Point to Jumper's Brook
2	S. 66° W.	3	20	23	23	To top of Bishop's Fall—a portage.
3	S. 49° W.	4	40	10	33	To the mouth of Great Rattling Brook.
4	" "	5	20	40	73	To the Pool below the Grand Falls.
5	N. 41° W.	1	76	145	218	To the bend of river above Grand Falls —a portage.
6	S. 54° W.	1	40	27	245	To the smooth water below Rushy Brook, including the chute above the Grand Fall, where there is a portage.
7	N. 82° W.	9	60	27	272	To the mouth of Ques-a-wet-quek Brook, current and smooth water; river wide with many islands.
8	S. 73° W.	2	40			To the outlet of Badger Brook at the great bend. Distance, without including minor turns, from the mouth, 37 miles 56 chains.
9	N. 79° W.	1	40	72	344	
10	N. 18° W.	2	0			
11	S. 49° W.	11	20	18	362	From Badger Brook to smooth water below Upper Falls.
12	S. 7° W.	0	48	36	398	Over the falls and the rapids above.
13	S. 54° W.	4	28	12	410	To the confluence of Noel Paul's Brook.
14	S. 66° W.	8	0			Makes a chord to a northerly sweep of the river over strong rapids and a chute of 5 feet.
15	N. 62° W.	1	40	18	428	
16	S. 50° W.	1	50			To Harpoon Brook.
17	S. 85° W.	2	32			To the outlet of Red Indian Pond.
						Total distance, exclusive of minor turns, 67 miles 34 chains.
18	West	10	40	..	..	From lake outlet to Buchan's Island, on lake.
19	S. 41° W.	14	40	..	..	From Buchan's Island to Narrows, south-west arm.
20	S. 60° W.	7	60	..	..	From Narrows to head of lake.
						Total distance from outlet to head, 32 miles 60 chains.
						From Wigwam Point to the head (by the courses), 100 miles 14 chains.

The ascent of the river by canoe or light boat, although not difficult, is tedious, as there are many strong rapids to encounter, and several falls and chutes, over which portages have to be made. The first of these obstructions is at the Bishop's Fall of 19 feet, above which, but particularly for 6 or 7 miles above the junction of the Great Rattling Brook, the river is more or less rapid all the way to the Grand Falls. The Grand Falls consist of a succession of chutes (one of about 30 feet), and violent rapids, somewhat over a mile in length, and giving altogether, from bottom to top, a rise of 145 feet. At a short distance above the Grand Falls,

IMAGE EVALUATION
TEST TARGET (MT-3)

6"

there is an abrupt chute of 15 feet, and above it the river continues to be rapid and turbulent, till reaching the smooth water of a lake-like expansion at the mouth of Rushy Brook. The ascent from Rushy Brook is but slightly impeded by rapid water, the current being moderate for upwards of 9 miles; but at this part the river attains, occasionally, a great width, being sometimes upwards of a mile from bank to bank, with many islands and gravel beds between, and is frequently so shallow as to render the passage of canoes extremely difficult. Above this expansion, or, more correctly, from the mouth of the Ques-a-wet-quek Brook to the junction of the Badger Brook, the river is continuously more or less rapid, and there is a chute at one place of about 4 feet, where a portage is made. Above the Badger Brook the current is for the most part always strong, and there are several interruptions from falls or rapids between it and the Red Indian Lake. Above the termination of the 11th course, there is a sharp fall of 27 feet; while on the 15th course there is a chute of 5 feet, over both of which canoes and baggage must be carried.

The lake itself, as shown in the courses given above, is 32 miles 60 chains long, from the inlet to the outlet; but there is an additional 4 miles in the total length, by including the north-east arm, which turns abruptly round in a north-easterly direction from the outlet, making it altogether nearly 37 miles from end to end. The width of the lake varies from half a mile to rather over 3 miles, being narrow at either extreme, and moderately wide about the middle, and contains an area of about 64 square miles. Buchan's Island, which is situated at the north-west angle of the lake, is the only island it contains, excepting a few insignificant islets in the south-western arm, and at the junction of the Upper Stream.

The principal tributaries to the Exploits River below the lake are, the Great Rattling Brook, Chute Brook, Sandy Brook, Aspen Brook, Badger Brook, Eh-quet-eg-a-weh or Noel Paul's Brook, and Harpoon Brook, while there are four large and important streams, which pour their tribute into the lake itself. In addition to those enumerated, the lake and river receive the waters of many smaller tributaries, too numerous to be separately described.

The Great Rattling Brook takes its rise in the central part of the Island, at an inconsiderable distance north or north-easterly

from the Jamieson Hill range, and the waters of the Pipe-stone Pond branch of the Bay East River (see Report of 1870), and flows generally in a north-easterly direction to its confluence with the main river.

The Indians report the head waters of the opposite flowing streams, as being in close proximity, and a canoe route by their course as being practicable. The upper reaches are represented as consisting of lakes or smooth water over long distances; but the lower parts, for many miles, as exceedingly turbulent, necessitating portages at many places, and as difficult and dangerous for canoe navigation generally.

The Chute Brook and Sandy Brook flow in a north-easterly course, draining a wide and generally level or undulating country, and join the main river on its right side; the former at the Grand Falls, the latter at the expansion of still water above Rushy Brook.

Aspen Brook takes its rise on the eastern flank of the Hodge's Hill range of mountains, and from wide and extensive marshes; and flowing southerly, falls on the left side into the still water of No. 7 course.

Badger Brook is a fine stream, easily navigable for canoes over many miles of its course. It joins the main river, on the left side, at the great bend where No. 10 course terminates. The ascent bears from the junction north-easterly for between 2 and 3 miles, at the end of which distance it divides into two branches of nearly equal size; the one bearing upwards nearly due north, the other still maintaining a north-easterly direction. The former of these branches is reported to take its rise from two parallel lakes, called the "Twin Ponds," about 24 miles due north from the confluence with the main river, and to maintain an almost straight course, expanding frequently into long but narrow lakes, for its entire length. The water of the "Twin Ponds" is also said to have an outlet at the northern extreme, which, flowing northerly, joins the waters of a north-flowing river, which finally terminates at the head of Badger Bay. The north-eastern branch rises in the flat regions north of Hodge's Hill, and being turbid and sluggish for many miles of its course, is easily ascended by canoes.

Eh-quet-eg-a-weh or Noel Paul's Brook comes in on the right side, at the end of the 13th course. It supplies a considerable body of water, draining a great tract of country upon the northern

side of the watershed, between the Bay East River and the Exploits. According to the Indians, the stream proceeds from a lake, which, resting exactly on the watershed, has outlets flowing in opposite directions, the south falling brook being discharged into Crooked Pond, of the Bay East River.

Harpoon Brook falls in on the right side, about 2½ miles below the Red Indian Pond. Its sources interlock with some small streams, which discharge their waters into Island Pond, the highest of the Bay East suite of lakes; and its course, sweeping along the base of the range known as the Harpoon Hills, meanders in a north-westerly direction to the junction.

At the head of the north-east arm of the lake a fine stream falls in, by the course of which there is an established canoe route, frequently used by the Indians, to Hall's Bay. The upward course is north-east for many miles, the brook flowing through a very level country, but it finally turns to the northward, bearing for the mountain range which separates the waters of the Exploits from those of Hall's Bay. The head waters of the south brook of the latter are said to approach the sources of this stream so nearly as to render the portage from the one to the other a matter of no great difficulty. At the time of our visit the brook was so reduced in volume as to be inaccessible at some parts for canoes, a circumstance, however, which, according to the Indians, only occurs in very dry seasons.

Another fine brook falls into the Red Indian Lake on the south side, about 4 miles above the outlet of the river. The Indians describe it as proceeding from a large lake, known to them as Victoria Lake, which bears nearly due south from the outlet, and is distant between 20 and 30 miles. A narrow watershed separates the tributaries above this lake from those that discharge into Island Pond, at the head of the Bay East River.

On the north side of the lake, nearly opposite Victoria Brook, a stream empties itself, by three separate channels, which unite about a mile back, and form a large rapid brook. It takes its rise on the southern slope of the mountain range, between the Exploits waters and the Grand Pond, and flows through a barren waste until within a few miles of the outlet.

The brook on the south side of the south-west arm, being a mere mountain torrent, is valueless for communication by canoe;

but a large body of water is discharged through its channel, being apparently the main drain of a system, dispersed through the mountainous tract of country westward from Victoria Lake.

The main river valley from Red Indian Lake downwards, is nearly for the whole distance a level or gently undulating country, broken only by occasional abrupt hills or rocky eminences, and densely wooded for many miles back, from either bank of the stream. The only mountain that attains great altitude, anywhere near the river, is Hodge's Hill, the highest summit of which was found by triangulation to be 1330 feet above the level of the sea.* Where the mountain reaches this altitude, it rises almost precipitously from the level plain of the north-east branch of the Badger Brook, bearing from the outlet at the end of course No. 10, N. 48° E., 9 miles.

From this point a range, high and bare, runs south-easterly, decreasing gradually in elevation as it approaches the river, below the confluence of Aspen Brook. The peak of Hodge's Hill is the most northerly of the three "Tolts" mentioned in my Report of last year.

On the northern side of the Red Indian Lake, below Buchan's Island, the land rises gradually from the shore into an alternation of rolling barrens and marshes, each range of hills attaining successively a higher elevation, advancing towards the mountain ranges of the Grand Pond. Those latter, striking in a south-westerly direction, approach the shores of Red Indian Lake, above Buchan's Island, and run, within a moderate distance from the margin, towards the head of the lake, thence up the valley of the Upper Exploits waters, pointing towards the "Long Range" south of St. George's Bay. The highest and most prominent of this range near the lake, are "Halfway" and "Notched" mountains; the altitude of the former being 1400 feet, and the latter 1555 feet above the sea. An isolated range of rugged mountains rises over the comparatively low country between the Victoria and south-west arm waters; the highest elevation of which was found to be about 1220 feet.

The forests of the Exploits Valley consist of pine, spruce, balsam-fir, tamarack, white birch, and poplar. On the lower reaches of the river and tributaries, below the Grand Falls, pine is

* Subsequently Mr. Howley in 1875 made the height to be over 2000 feet by aneroid.

or has been abundant, some of it apparently of good quality for conversion into ordinary lumber; but there are extensive areas, especially near the Great Rattling Brook (3rd course), where the timber has been completely swept away by fire. Moreover, on the more accessible parts of the region, many of the most valuable trees have disappeared, having been culled out long since to supply logs to a saw-mill, which formerly was in operation near the outlet of Peter's Brook into Peter's Arm. The enterprising firm of Winsor and Vallance, however, who have now established a steam saw-mill on the coast, between Peter's Arm and Wigwam Point, still procure a large supply of material from these reaches, many piles of which were observed on the banks of the river, awaiting a freshet to be driven down to the sea.

Between the Grand Falls and Badger Brook, at many parts, on both sides of the main river, pine was observed to flourish luxuriantly, much of which appeared to be of excellent quality, being often of fair diameter, straight and tall. These reaches also display a fine growth of other varieties of timber, and at some parts, especially about the forks of the Sandy Brook, white birch often attains a very large size; this being one of the few localities where the Indians procure bark capable of being used for the construction of canoes.

Above the junction of Badger Brook the surface of the country is exceedingly level, over a very wide area on both sides of the river, up to the upper falls, and is densely covered by forest of the usual varieties; but the trees at this part are for the greater part small, being the immature successors of the ancient forest, entirely destroyed many years ago by fire.

The character of the country, between the upper falls and the Red Indian Lake, differs in some degree from that below, the surface is more irregular and rocky, and low rounded hills rise at a short distance from the river on either side, but the whole region is still densely wooded, and good pine and other timber is not infrequent, being remnants of the old forest which had escaped the great conflagration.

On the flats near the northern margin of the Red Indian Lake, particularly at the outlets of the larger brooks, pine and spruce trees of large size, straight and tall, were frequently observed; but back from the lake the timber is of stunted growth and of

little value, scattered in detached woods over the surface of the great marshes and barrens. The southern side of the lake is densely wooded to the water's edge, and the country inland appears to be all forest for many miles back, broken only by occasional marshes or swamps, which occupy the lower grounds between the ridges. The Indians who have visited the Victoria Lake, state that good pine and spruce are abundant on the lower reaches of the brook.

It has already been stated that the land throughout this valley is generally level or gently undulating; and it will be perceived that the quality of its spontaneous production may fairly be taken as indicative of a fertile soil. The width of this fertile belt of land varies at different parts of the river, but taking it to average about 2 miles on either side (and it probably is much more), there would be an area of reclaimable country of about 280 square miles, or 179,200 acres, exclusive of the country around the lake, much of which is also available. At the mouth of the river, the reclaimable land extends to the northward for about 5 miles, terminating with the northern arm; and there are large tracts around Norris' Arm, and on the valley of the Little Rattling Brook, which are capable of cultivation. The fertility of the soil, at this part of the region, is amply testified wherever cultivation has been attempted, producing roots, potatoes, grass, and other crops of the finest description, while as a grazing or stock-raising country it can hardly be surpassed. The surface soil is generally of sand or a sandy loam, which at the upper part of the valley is underlaid by a drift of clay and gravel, while at the lower parts the subsoil is tenacious bluish or drab-coloured clay, which is occasionally slightly calcareous.

No observant person visiting the valley of the Exploits could fail to be impressed with the manifold advantages it presents for the prosecution of industrial pursuits, such as lumbering and agriculture. With a splendid river, abundant timber, and a fertile soil, the region that is now a wilderness, might, by energy and enterprise, be soon converted into a thriving settlement, maintaining a large population. The first step likely to lead to this desirable end is evidently to open out a road, parallel to the general course of the river, into the interior. The difficulties attendant upon such a work are apparently not great for many

miles, especially on the south side of the main stream, where the only obstruction of any consequence are the crossings of the tributary brooks, where, however, material is always near at hand for the construction of bridges. If the Indian statements are to be relied upon, such a line of road might be extended up the upper valley of the Exploits, without incurring any serious engineering difficulties, until reaching the head waters of the river, among the Long Range of Laurentian mountains, where the watershed would be crossed, and a descent made by one of the valleys to St. George's Bay. Such a medium of communication, together with the route, suggested in last year's Report, from Bay D'Espoir, would bring into connection all the most important districts of the Island, whether for mining, lumbering, or agriculture.

Should it be deemed advisable to open up this country at some future time, I would respectfully refer your Excellency in Council to the views expressed regarding settlement upon wild land, in my answer to query No. 4, on page 39 of the Report of the Select Committee of the House of Assembly, upon the Geological Survey. To the principles there laid down I still adhere, and refer to them, on the present occasion, to urge the necessity of adopting some systematic plan for the disposal of such lands, either by licence or grant, to future applicants. If the experience of other countries may be admitted to act as a guide to the means of progression in this, it will be found that the pioneers of the forest will, in most cases, be the lumber-men, whose operations will lead eventually to permanent occupation, and settlement upon the lands. But, as stated in the Report above alluded to, the area required for a *timber limit* is very different from that required for an agricultural lot, of which the recipient would obtain the *fee-simple*. If it be desirable that the manufacture of lumber should be encouraged at all, the limits must be extensive for each licence, and boundaries accurately defined; in which case it will be to the interest of the parties holding such licence, to economise and protect the timber: whereas, if confined to lots of small dimensions, which by no possibility could yield a remunerative supply for even the smallest description of saw-mill, they must either abandon the work, when the stock is exhausted, or cut down and remove indiscriminately all that comes within their reach, without regard to proprietorship, whether public or private. Again, it has been shown that

extensive groves of pine occur on each side of the river above the Grand Falls. Now, were lumbering on a large scale encouraged, there can scarcely be a doubt but that a prosperous trade would spring up there, giving employment to hundreds of men, many of whom would ultimately take up agricultural lots, and settle upon the land. It has, indeed, been urged that the Grand Falls present an obstacle to getting lumber down to the sea; but this is by no means insuperable, and with ample means and proper appliances would be easily overcome by the construction of slides or tramways, such as may be seen at all such obstructions on every tributary of the Ottawa and elsewhere.

Gander Bay and River.

While Mr. Howley was engaged in examining the coast of Gander Bay, he took the opportunity of ascending the Gander River, and making a partial survey of its course, for about 15 miles above the tide-water. The ascent is represented as bearing nearly due south for the lower 2 miles; above which it bends to S.S.E., and becomes rapid for a mile, and then to open into a wide expansion containing numerous islands. In this last course the current is strong all the way, and there are three rapids of considerable velocity, which altogether give a rise of about 15 feet. The course then bears up about south by west, passing through a group of islands for 2 miles, above which, on the same bearing, the river becomes open and wide for between 7 and 8 miles, contracting at an abrupt turn to the westward, a little above which the measurement terminated. This bend is in lat. 49° 5′ N., and long. 54° 33′ W. The upper waters of the stream, which were struck during the survey of 1871, are in lat. 48° 18′ N., and long. 55° 52′ W., from which it will be obvious that the general course of the river to the end of Mr. Howley's survey is nearly north-east, and the distance between the two points, in a straight line, between 70 and 80 miles. One of the largest lakes in the Island is known to belong to these waters, the entrance to which, by the course of the river, is said to be about 30 miles above the outlet into Gander Bay.

The country on both sides of the Gander River and its estuary is represented to be level and richly clad with timber, over a very great area. Forests of pine are said to be of vast extent, con-

taining trees of remarkable size and valuable quality. The coast settlers, who frequently ascend the river to the Gander Lake, state that the same character equally applies to the whole region, at least as far as the lake, and probably farther, and there being no impediments of any consequence to the navigation all that distance, an incalculable supply of lumber might easily be driven down to the sea.

There can be little doubt about the capabilities of a very great area of the Gander River country for settlement; the timber bears ample evidence to the fertility of the soil, while the level character of the surface offers every facility for constructing roads in nearly all directions. Mr. Howley represents the intervening bays and arms between Gander Bay and Exploits Arm, to present in many respects the same evidences of fertile soil as those seen upon the Gander River, and is of opinion that there is no important physical difficulty to be encountered in establishing direct communication by road between the two extremes.

Distribution of the Formations.

In former Reports I have shown the existence of two deep parallel depressions running diagonally across the Island; the one by the main valley of the Humber and Deer Pond, the other by the Grand Pond waters and the Indian Brook to Hall's Bay. The courses given of the valley of the Exploits and Red Indian Pond will be seen to form a third geographical feature corresponding with the other two, while the general course of the Gander River constitutes a fourth. In the central parts of the two former depressions, a trough of the Carboniferous formation was found to be spread over a wide area of country, supported upon a base of Laurentian gneiss, the eastern boundary of which runs along the eastern shores of the Grand Pond. It was in a great measure to determine, with some degree of accuracy, the true eastern boundary of this important formation, that the survey of the Exploits was resolved upon, as there were reasons to suspect the probability of another outlying patch or detached trough being brought in, occupying the lower grounds of that valley. Another important matter in view was to ascertain the run of the metalliferous rocks of the Jamieson Hills, which, as suggested in the Report of last

year (1871), might reasonably be expected to exhibit themselves at some part of the Exploits Valley.

The evidence obtained in the course of the survey has not verified either of those anticipations; but has shown that the geological formations which occupy the valley and lower features of the main river, below the Red Indian Pond, are of older date than the coal measures, and more recent than the Quebec group, as shall be presently explained.

The rocks most extensively exhibited on the coasts and islands of Notre Dame Bay, bear, in lithological character, a general resemblance to those of the Quebec group, consisting of magnesian strata in a large degree, associated with quartzites, diorites, conglomerate, and slates. There may, however, be present other members of the Lower Silurian or older systems, connected with these, which, in the absence of organic remains, are exceedingly difficult to identify.

Resting unconformably upon these strata, more recent formations are spread over a large area in the Bay of Exploits, and for many miles up the Exploits Valley, and are found also in some detached outlying patches at the western parts of Notre Dame Bay. These in many parts abound in fossils, often in a good state of preservation, most of which are typical of the lower part of the Upper, or upper part of the Middle Silurian system.*

Of still more recent date, there is a great display of igneous or eruptive rock of various mineral qualities, which has greatly disturbed and altered the sedimentary formations for the whole length of Exploits River and Red Indian Pond, and at many parts of Exploits Bay.

For convenience, in the meantime, in describing the geology of this section of country, I shall describe the rocks under the denomination of the *Lower* and *Upper* formations.

Lower Formation.

Many of the characteristics usually found to prevail in the Quebec group of rocks, are displayed in the coast cliffs of the

* There are many more fossils still to be examined from various parts of the region, which may prove the existence of an older horizon than those mentioned here, particulars regarding which will be given hereafter. The structure is too complicated at some parts to describe with any degree of certainty in the meantime.

Twillingate Islands, where the strata are in great part of magnesian quality, associated with quartzite and diorite; but the disturbances which have affected the formation here, and indeed over the whole region, are so very great, that it is almost impossible to ascertain at any part the superposition, sequence, or vertical thickness of the mass, with any degree of accuracy.

Taking the section exposed in Wild Cove, of the Northern Twillingate Island, as an example, the apparently lowest stratum is an impure serpentine, of a dark green colour on fracture, weathering a rusty brown, or sometimes yellowish, occasionally streaked or patched with epidote, from 20 to 30 feet thick. This is succeeded by a massive irregular bed of conglomerate, the matrix of which is a pale yellow, or whitish, very crystalline dolomite, containing rounded pebbles of opaque white quartz, which vary from the size of a pea to that of a hen's egg, and some flattened pebbles of dark green slate. The exposed surfaces of this last stratum weather always a bright ochreous yellow. The conglomerate is then overlaid by a mass of soft shaly rock, very unctuous to the touch, of a pistachio green colour, and otherwise resembling an impure serpentine. It weathers blackish green, and is sometimes mottled by dark, rusty, reddish spots, and is sometimes found to contain concentric concretions, somewhat in the form of a flattened sphere. These strata are intersected by numerous small veins of white quartz and bitter spar, and the ores of copper and iron, especially the latter, in the form of pyrites, are of frequent occurrence.

The corrugations by which these rocks have been affected are so sharp, and the repetitions so frequent, that they may be seen rising up and passing down in a succession of folds, for a long distance along the shore, and thereby must occupy a considerable area of surface, although the total thickness is by no means great. In the eastern bight of the same cove, some hard compact beds of a greenish-grey quartzite, from 1 foot to 18 inches thick, were observed to alternate, with rocks of dioritic character, in thick strata of a blackish-green colour in the mass, abundantly marked and mottled with epidote. The surfaces of the quartzites occasionally weather a pale pink or rose colour, while the diorites weather black or very dark brown. A surface on one of these beds gave a dip S. 12° W. $<$ 60°. Following the coast of Wild Cove to the

eastward, the whole of the above strata seem to be again brought to the surface by a transverse or north and south fault; and towards the point a dolomitic conglomerate was observed to pass between two masses of impure serpentine, which was underlaid by quartzites, divided by partings of green nacreous slate. A complete overturn is conspicuously displayed at the eastern point, near which a trap dyke, about 4 feet thick, was seen to intersect, running nearly due north and south. Passing round the headlands of the greater Twillingate Island, Baccalao, and the north point of New World Island, the cliffs present a scene of confusion and disturbance that defies description. The rocks are shattered, twisted, and contorted into every conceivable form, while great faults occur repeatedly, bringing remote members of the formation into close juxtaposition. For the most part, the strata of these cliffs are of harder quality than those seen on the Northern Twillingate Island, and so far as could be ascertained, they seemed chiefly to be composed of quartzites, diorites, and slate. These characteristics continue in a greater or less degree until entering Goldson's Arm, New World Island, where the unconformable conglomerates and sandstones of the upper series are brought in. The north-western shore of Goldson's Arm constitutes the south-eastern boundary of the older formation, the cliffs of which are of diorite, magnesian slates, and a pale yellowish dolomite at the base, which is interstratified with bands of blood-red jasper, from 5 to 7 inches thick. These strata are nearly vertical, the inclination generally towards the north-west. The resemblance, in many respects here observed, particularly in the presence of red jasper, suggests the probability of this mass of strata being the equivalent of the lower measures, exposed on the northern side of Notre Dame Bay, between Tilt Cove and Snook's Arm.

The south-eastern boundary of the formation is well marked in a low depression of the land, running from the head of Goldson's Arm, in a remarkably straight course, south-west, to the head of Indian Cove, on the main tickle; thence it strikes in the same direction across Friday's Bay, southward of Trump Island, crosses the north-west peninsula of New World Island to Luke's Arm, and runs in the direction of the Sugar Loaf, south from Sampson's Island. Here the course runs below the sea, and is probably interrupted by a mass of syenite, which was found to form Swan and

Long Islands, and bearing thence about south by west, touches the western shore of Birchy Island, and of the Burnt Arm. On the western side of the syenite, the formation is again recognised at South Head; it occupies the whole of Thwart Island, and thence runs along the main shore of the northern arm of Exploits. From such evidences as have been ascertained, it seems probable that the terminal outcrop turns to the northward and north-west, at no great distance from the northern arm, and bears generally for the southern shores of Hall's Bay, where it comes against gneiss; but further investigation is still requisite to determine many points in this connection.

Proceeding to the westward, Mr. Howley had not an opportunity of closely examining the coast sections until reaching Triton Island, although he has little doubt, from the aspect and condition of the exposures observed from the vessel, that the rocks are all or chiefly of one horizon. The strata of Triton Island, near Triton Harbour, consist of dark greenish slates, with beds of quartzite, mottled with epidote, some of which are 2 feet thick, and bands of red jasper, from 6 inches to a foot thick. Veins of white quartz and bitter spar are frequent. The attitude of the strata is almost always nearly vertical; but it appears, as at Twillingate, to be frequently repeated by a series of sharp corrugations. On the north side of Pilley's Island, the rock is principally a soft, crumbling, greenish slate, with occasional beds of a pale yellowish dolomite. These are thickly reticulated by small veins of white quartz and bitter spar, and the cliffs are much stained by green carbonate of copper.

At Sunday Cove Island slates and dolomites are again exposed, with a mass of diorite, apparently at the base, which indicates the presence of copper, with iron pyrites to a large extent. At one place a metalliferous belt, of from 10 to 12 feet thick, was observed in the slates, with occasional interstratified layers of solid iron pyrites, from half an inch to 3 inches in thickness, in which yellow copper is disseminated in patches and specks. A little distance from the metalliferous belt, a quartz vein, about 2 feet thick, intersects the strata running east by south, in which copper ore is thickly disseminated. It was observed that the ore was chiefly diffused through a thickness of about 6 inches on the south side of this vein, as far as it could be traced, which, however, was not far,

as it runs from the shore into a dingle or notch in the cliff, and is concealed below débris.

Portions of the formation are exhibited on the northern head of Hall's Bay, on Little Bay Island, Little Bay Head, and all the points of Three Arms of Green Bay. On these northern points there would appear to be a preponderance of strata of a slaty character over the other usual material, some of which was remarkable for a concretionary structure. Iron pyrites abounds in these slates, and the cliffs are in many places streaked with carbonate of copper, while the ores of that metal are represented as having been observed in considerable profusion at various parts of the Three Arms, and at the northern head of Hall's Bay.

During the season's explorations, the only exposure that was recognised, as part of this formation, southward from the boundary already indicated, was on the Gander River, about 12 miles up its course, where a small section of serpentine composes the bank, from 5 to 6 feet high, extending for about 150 yards along the western shore. The area occupied by members of the formation at this part has not been ascertained; but the gently undulating nature of the surface of the country around is strikingly dissimilar to the features usually presented by the series, and it was supposed that the section in question might be of very limited extent, and was brought to the surface on the axis of an undulation, protruding through the lower measures of the unconformable and superior formation.

Upper Formations, Trap Dykes, and Overflows.

These formations appear to be distributed in the form of a rudely elliptical trough, with many irregular and deep indentations on either side, extending from the vicinity of Ragged Harbour, on Sir Charles Hamilton's Sound, on the north-east, to the Victoria Brook, on Red Indian Pond, to the south-west. The northern outcrop runs in an irregular line through the Indian Islands, south of Fogo, towards the Change Island Channel, makes an abrupt turn to the northward by the Change Islands, and is recognised again at Herring Head, on New World Island, striking south-westerly towards Goldson's Arm. Thence the contact with the inferior rocks is tolerably well marked to the northern arm of

Exploits. Nearly the whole valley of Exploits appears to be spread over by one part or another of these formations; but the breadth of area on the northern side of the river is more limited than that on the south, as the final outcrop on the former side appears to run in a moderately straight line, from the northern arm to the confluence of the Badger Brook, and thence on to the north-eastern arm of the Red Indian Pond. The southern boundary has not yet been traced out; but the level character of the country on the south side of the Exploits River seems to favour the probability of the formation being extended over a great area in that direction. The most southern outcrop seen on the Gander River is between 7 and 8 miles up, within a short distance of the exposure of serpentine, whence the general strike would carry it roughly parallel with the main shore, towards the coast opposite the Penguin Islands, where it rests upon Laurentian gneiss. The evidences, so far, tend to show that while the formations butt up against the Quebec group on the northern and southern sides of the trough, they overlap the junction of the latter at the eastern and western extremes.

The central part of this elongated trough has been greatly disturbed for the whole length of its course, from the head of the Red Indian Pond to the Dildo Run, where vast dykes were seen to cut through the strata at very many parts, while great areas are spread over by overflows of trap, or breccious intercalations. These eruptive masses appear to run diagonally across the trough from Dildo Run to the north-east, bearing for the northern end of Change Islands and the north-western head of Fogo; thence on to the small islands beyond, in the same direction, where they probably come in contact with a portion of the lower formation, at no great distance from its junction with the Laurentian gneiss and granite, of which the greater part of the Island of Fogo is formed. By a glance at the map it will be immediately perceived that the course of this igneous action runs in a remarkably straight line north-east and south-west, and has, doubtless, given origin to the peculiar geographical features the region presents, and to the depression of the Exploits Valley. Moreover, the exact parallelism which obtains in this case, with the other main topographical features to the north and to the south, may be presumed to indicate that similar agencies were in active operation at the same

or a subsequent period along the lines of all these great valleys. In the valleys of the Grand and Deer Ponds the evidences appear to show that such movements were in operation at all events at as late a date as the Carboniferous period.

The base of the Upper and unconformable formation consists of conglomerate and sandstones, with slaty divisions, which, at Goldson's Sound, seem to come against the older and altered rocks in a slightly oblique direction, as if brought into their present position by a fault, the lower beds dipping about S. 55° E. < 24°. The lower conglomerates are of a reddish general colour, the matrix being constituted of fine reddish sand, sometimes slightly calcareous, which encloses well-rounded pebbles of quartz, red jasper, green jaspery slate, and fragments of magnesian rocks. The pebbles are not usually large, the largest being about the size of a hen's egg. The strata in ascending succession are still of conglomerate character, but the colour gradually passes into grey, and there are numerous pebbles of gneiss and syenite mingled with the other qualities, and they are frequently characterised by the presence of hard, blue, or blackish cherty concretions, which weather a bright yellow, are sometimes concentric in structure, and of an elliptical shape. The islands of Goldson's Sound expose an alternation of conglomerates and red sandstones, with dark grey slates, which are themselves occasionally finely conglomerate, and were found to contain numerous stems of encrinites. The dip of the slates is S. by W. 80°. In front of the encrinal beds, on the long projecting point between the Arms of the Sound, and on the islets at the head of the northern arm, some strong beds of coarse conglomerate are exhibited, which are overlaid by black or dark grey slates, with thin beds of grey sandstone, of from 1 to 6 inches thick. The conglomerate is often very calcareous, and frequently contains irregular intercalations of limestone. The dip of these rocks is S. 20° E. < 60°. Both the conglomerates and associated beds above the encrinal slates were found to be very fossiliferous, and in their strike up the southern shore of the eastern arm, were there found to pass beneath another mass of coarse conglomerate, which forms the escarpment to the hills, which strike in the direction of the point between Pike's and Little Cobb's Arm. The total thickness of this part of the formation, from the junction with the

older group to the last-mentioned conglomerate, was estimated to be about 2000 feet.

The fossils recognised in the strata alluded to, appear to be types of the Middle or Upper Silurian series, or about the horizon of the Llandovery group of the British Survey. Some of those previously collected were referred to Mr. Billings, of the Canadian Survey, who identified the following genera and species:—

Favosites Gothlandica, Heliolites? Zaphrentis bellisriata, an encrinite referred to the genus *Glyptocrinus,* a coral referred to the genus *Heliophyllum, Orthis ruida, Leptæna sericea,* or perhaps *Transversalis,* ventral valve of an orthis like *O. Davidsoni, Strophomena rhomboidolis, Atripa reticularis, Stricklandinia lens, Modiolopsis, Ambionychia,* a trilobite, genus *Encrinurus;* and some others not determinable.

The conglomerates of the escarpment above mentioned are succeeded by a set of slates which are occasionally slightly micaceous, with beds of quartzite from 2 inches to a foot thick, the strata of which run out upon the coast on the south-east side of Goldson's Sound, usually called Burnt Arm, at the head of which arm the slates pass beneath a mass of limestone, with black slate and trap breccia. At this part trap intrusions are met with, and the strata are violently disturbed, and altered in some parts in such a degree as to assume somewhat the aspect of the inferior formation; but the occasional presence of fossils, amongst which was one resembling *Zaphrentis,* and some *Encrinites,* was supposed to indicate a horizon of later date than the Quebec group.

Following up the section across New World Island to Cobb's Arm, the strata appear to be folded over by sharp undulations, the axes of which run north-east and south-west, and at Great Cobb's Arm, the limestone with black slate, and trap breccia is largely exhibited, the fossiliferous slates coming in at the upper part of the arm, and apparently passing below. Beneath the limestone at Cobb's Arm a set of jet-black shales were found to contain *Graptolites,* and the limestone is succeeded above by a set of grey calcareous slates, with occasional beds of pale grey sandstone. These extend across to the southern shores of the Island at Dildo Run, where they come against the trap in a vertical attitude. Among the fossils found in these slates, which were generally rather obscure, was one very much resembling *Discina*

Pelopea (page 51, "Palæozoic Fossils," 'Geological Survey of Canada'), and some well-marked fucoids.

In the eastern prolongation of the trough, beyond the belt of trap, limestone with slate make at some parts a great display. The greater part of the Indian Islands is of slate, much of which is black, with smooth silky surfaces, and a cleavage parallel with the bedding, and occasional beds of grey arenaceous rock interstratified. The general strike is east and west, the strata inclining to the south at a very high angle or vertical. The southern shore of the Eastern Indian Island is skirted by a grey, shrivelled, calcareous slate, which is intercalated by irregular or lenticular masses of limestone, which in their western strike are more fully developed upon Yellow Fox Island. Here the calcareous masses range from 10 to 30 feet thick, and contain abundance of fossils, chiefly corals and encrinites. The structure of the limestone intercalations is slaty, and it was found that the base of the lowest band was thickly sprinkled throughout with coarse, globular-shaped grains of sand of a brick-red colour. On the south side of Yellow Fox Island the slates alternate with thin beds of slaty limestone from 4 to 5 inches thick, which are filled with broken stems and fragments of encrinites, together with a few remains of corals resembling *Zaphrentis*, and others more obscure. A spiral univalve also was found at one place, at the eastern end of the same island, resembling a *Murchisonia*.

The rocks exhibited on the Indian Islands rise again on the south side of the synclinal, and appear to have a considerably wide spread over the region between Ragged Harbour and Gander Bay. They were also observed upon the Gander River, and probably occupy a great area between that river and Exploits Arm.

Between the northern arm of Exploits and the mouth of the river, the coast displays sections of considerable volume, consisting of sandstones, conglomerates, and slates, representing the measures seen at Goldson's Arm. The exposures between the Northern and Peter's Arms are in a disturbed condition, being cut up by several greenstone dykes. Here the same strata are several times repeated by a succession of undulations, dipping in opposite directions, north or south; but between Peter's Arm and Wigwam Point, the dip is moderately regular and always to the southward,

varying in the rate of inclination from 40° to 80°. There appeared, however, to be evidence of a repetition of strata at one place, by means of a transverse fault, with an upthrow on the south side, allowing for which, the thickness of the accumulation is nothing less than 2300 feet. The lower measures of this section are less of conglomerate character than the equivalent at Goldson's Sound; many of the beds are very calcareous. The colour is in great part of various shades of red, passing into brown or greyish. Many surfaces are very distinctly ripple-marked, and the thicker and more shaly beds always exhibit the elementary layers of deposition, usually called *false bedding*. The only fossils that were recognised in these arenaceous rocks were fucoids; but at the top of the section, near Wigwam Point, and at Norris' Arm, a mass of conglomerate, with calcareous intercalations, contains organic remains in profusion, of types exactly corresponding with those already enumerated from Goldson's Sound.

The conglomerate, with fossils and calcareous intercalations, comes out on the left bank of the river at Martin Eddy Point, about 3 miles above Wigwam Point, where it dips N. 65° W. $<$ 65°, while on the opposite bank the dip is south-westerly; but at the turn of the stream, opposite Jumper's Brook, an intrusive mass of trap reveals the cause of the disturbance, by which or similar agencies the strata have been affected more or less for the whole length of the river's course. Running nearly with the river's bed, this trap cuts through the arenaceous deposits, and gives rise to a set of short folds, or wrinkles, on either side of the intrusion, which are beautifully displayed at the Bishop's Falls, where the axes of the corrugations run N. 65° W., S. 65° E. The prevailing colour of the sedimentary rocks is reddish; but there are portions that are grey, and others greenish, and some parts are micaceous. The lower beds at Bishop's Fall are slaty in structure, with thin interstratified layers of sandstone, the whole overlaid by strong massive beds of sandstone, with partings of green and greyish arenaceous slate. The surfaces of both the thick and the thin beds are nearly always ripple-marked; but although some obscure forms, which may have had an organic origin, were frequently perceptible, no fossils were discovered sufficiently well defined to be identified.

At the lower part of the Grand Falls a great dyke of green-

stone, from 40 to 50 feet wide, intersects a set of slates and quartzites, running a little obliquely across the river S. 49° W., N. 49° E. The rocks on each side of the dyke are much altered near the contact; are hard, compact, and brittle, and break with a choncoidal fracture. At a little distance from the intrusion, there are some reddish strata of a slaty structure, and a few beds of conglomerate; but the mass consists chiefly of black ferruginous slate, containing small lenticular fragments of limestone, of a dark blue colour and very fine texture, which weather a bright yellow, and thin bands of from half an inch to 1 inch thick of black chert.

At the top of the Grand Falls the red sandstones are again displayed, dipping S. 76° E. < 50°, with great regularity; but above at the chute, great disturbance is once more manifested, and another trap dyke, about 20 feet thick, runs across the river, N. 18° E., S. 18° W.

The rock exposures above the chute consist in a great measure of trap breccia, containing angular fragments of slate, some limestone, and not unfrequently pure white calc spar, the latter sometimes in small thin seams or veins, and also in masses filling up cavities. There are also exposures of a bright sea-green slate, a little below Rushy Brook, above which the rocks are concealed upon the river for several miles. At the chute below the confluence of the Badger Brook, the banks exhibit strata of a like description to the above, associated with sandstones and conglomerates, dipping northerly, above which more slates with thin layers of compact sandstone, from 1 to 2 inches thick, are brought in, and accumulate upon a dip < 50°, for about 300 yards. The surfaces of these slates weather black or dark brown, and are fretted by numerous, usually small, circular holes, some, however, upwards of 6 inches in diameter.

Above the Badger Brook, a set of very ferruginous slates, with intercalations of limestone and bands of black chert, occupy the banks, nearly all the way to the upper falls, where they are exhibited in great disturbance, and brought into contact with compact strong beds of quartzite, by dislocations. In the slates *Graptolites* were found in certain zones in great profusion. Masses of limestone are intercalated, both with the graptolitic slates and the more solid rocks below; in the first case, in lenticular forms of various thicknesses from 3 inches to 3 feet; in the second, in

the form of elongated flattened spheres, or in nodules; while some beds are speckled by small white spots of carbonate of lime. Some surfaces were found to be covered by fucoidal remains. Obscure forms, suspected to be corals, were observed with the calcareous masses, and occasional beds were ripple-marked. The graptolitic slates and associated strata, striking up the river, were recognised at several parts between the upper falls and Red Indian Pond; and finally, near the entrance to the Victoria Brook, where some strong bands of limestone constitute a part of the section, displayed in a series of acute corrugations; but at the lower part of the lake the rocks are of intrusive greenstone or trap breccia. A dyke of uncertain thickness runs into the lake at the upper end of the north-east arm, bearing for and reappearing at the western end above Buchan's Island, where it assumes a columnar basaltic character, the columns mostly pentagonal in shape, and inclined to a nearly horizontal position. Thence it runs near the margin of the lake in the direction of the Upper Valley, and at the foot of the Laurentian hills, immediately inland. Coarsely breccious rocks, which are often very calcareous, occupy the shores on each side of the dyke at the lower end of the lake, in which irregularly shaped masses of white, and sometimes pinkish coloured, carbonate of lime were often found to occupy the cells and cavities, while large angular fragments of quartzite and slate are bound together by a trappean paste. It was occasionally observed that a structure resembling a coral (*Favosites*?) occurred in the calcareous portions of the breccia.

Some isolated patches of the formation were observed on Long Island, Little Bay Island, and at Hall's Bay Head, in Notre Dame Bay. On Long Island the strata consist of black slate, which sometimes holds spherical concretions, overlaid by a thick bed of limestone, holding encrinites, which is succeeded above by sandstones and conglomerates. These were found to occupy the narrow isthmus between Cutwell's Harbour and Lush's Bight, in the form of a trough, with the longer axis bearing nearly east and west, flanked upon each side by great masses of porphyry, which constitute the rest of the island. Some small trap dykes run nearly in the strike of the strata, intersecting them obliquely.

The central part of Little Bay Island appears to be composed of porphyritic trap, with a great amount of feldspathic rock,

probably a volcanic ash, in which obscure lines of stratification were sometimes visible. On the east and on the west side of the island strata of conglomerate and sandstone come abruptly against these rocks, the latter apparently having protruded through and on the east side overturned the sediments, which dip towards them. The conglomerate is usually very coarse, and sometimes brecciated—fragments of angular rock, consisting chiefly of porphyry, often upwards of 2 feet by 1, being frequent, while at other parts of the same beds the pebbles are small and distinctly rounded. The sandstones which succeed the conglomerate beds are of fine grain, very compact, and of a bluish-grey colour, and are frequently characterised by small seams and nodules of white and occasionally pinkish calc spar. A small islet off the north-west angle of the island exposes several layers of limestone, some of which are pure white, resting upon beds of compact sandstone or quartzite, and is overlaid by 10 or 15 feet of conglomerate with arenaceous slaty divisions. Fossils are abundant in the limestone, although usually obscure; among which are several turbinated shells, one resembling a *Pleurotamaria*? an *Orthocera*, and encrinite stems.

At Hall's Bay Head rocks of the Upper series come in contact with the lower formation, where the junction is marked by a dingle or depression running across the point, bearing north-west and south-east. Between the dingle and the headland is all occupied by members of the Upper group. The strata are conglomerates, slates, and sandstones, the upper beds of which are coarsely conglomerate, and appear to correspond with the conglomerates of Little Bay Island.*

Economic Materials.

The frequent occurrence of the ores of copper in the rocks of the older series, and especially near those of magnesian quality, favours the probability that some localities will be met with in the region of Notre Dame Bay, where mining operations may be advantageously pursued; but it must be borne in mind that the extraction of metalliferous ores is at all times very uncertain, and invariably, even under the most favourable circumstances,

* More particulars regarding these rocks, and of the traps, &c., of the region generally, will be given hereafter, accompanied with a map of illustrations.

attended with great expense, before a remunerative return is possible. Many futile attempts have already been made at certain parts of Notre Dame Bay and elsewhere, to open up copper mines, which have, one after the other, been abandoned, not so much on account of the absolute absence of the expected ore, as by the indiscriminate and unsystematic manner in which the experiments were directed. If grantees of locations were to make accurate superficial surveys of their grants, and to lay down every particular correctly on a plan on a good scale, as their preliminary step, they would save a vast amount of trouble in the future, whether the adventure proved successful or otherwise, and they would be enabled to represent the circumstances intelligibly to other interested parties. Hitherto considerable sums of money have been uselessly expended in sinking shafts and driving drifts, apparently without any consideration as to local peculiarities or geological distribution; whereas, had correct superficial surveys been made in the first instance, the probable cost of which would be infinitely less than experimental openings, the facts afterwards recorded on paper would be found to guide subsequent operations, in the conduction of underground excavations, or be of a nature to deter proceeding further in a process which must terminate in inevitable loss.

The indications presented at the Twillingate Islands, at Sunday Cove Island, Pilley's Island, the Three Arms of Green Bay, and other parts, may be in many cases worthy of a fair trial; and a plan of the selected ground, upon a scale of, say 4 chains to 1 inch, accompanied with profile sections, would probably show whether the outlay of extensive excavations would be warrantable; nevertheless, the diffusion of metalliferous ores, whatever their mode of occurrence, is almost always so fickle and inconstant that no foresight is capable of determining the eventual result with certainty.

Building material of various qualities abounds in Notre Dame Bay and adjacent regions, some of an enduring and elegant description, and conveniently situated for shipment. The syenite of Long Island, Exploits, may be particularly recommended as one of these; it is a feldspathic rock of a reddish colour, fine grained, and compact, but being regularly divided by rectangular joints, may be easily quarried out in blocks of any required dimensions;

many such are already to be found naturally removed and strewed upon the beach. There is good anchorage close by, or in a cove at Swan Island immediately opposite, where the material might be shipped without danger or inconvenience. Similar rocks occur on Swan Island, Red Ochre Island, and on Birch Island.

On the islands in Dildo Run, especially on Dunnage, Shell-Bird, Dog, White, and Chapel Islands, there are varieties of porphyry of an excellent description for building purposes. Many of these are of a dark-grey general colour, and are very hard, but appear to dress well, and make a handsome and lasting material. Porphyries also occur on Long Island of Notre Dame Bay, and the neighbouring islands.

A grey micaceous sandstone is represented on the eastern side of Change Islands, as being a good building stone; as are also some of the gneissoid beds and syenites of Fogo and the Wadhams.

Among the sandstones of the section between Peter's Arm and Wigwam Point, some beds are remarkably well adapted for building purposes; particularly near the base of the section at Peter's Point, where some bands of the strata are of a yellowish-grey colour, in solid beds of from 10 to 18 inches thick, slightly calcareous, which dress with great ease and give a handsome surface. This rock, running up into a cliff close by the water's edge, would be easily quarried, and is most conveniently situated for embarkation. The thin beds of the same section are in many cases well adapted for flagging.

Exposures of limestone occur at Great Cobb's Arm and Burnt Arm of Goldson's Sound, in New World Island; at the Salt-pans in Friday's Bay, Lush's Bight on Long Island, and Little Bay Islands of Notre Dame Bay. At Great Cobb's Arm an almost unlimited supply may be derived from the cliffs of the sea-shore alone, where, indeed, it is already partially quarried, and has proved by actual experiment to be of excellent quality for all the ordinary purposes of lime. Schooner loads of this limestone are annually transported to St. John's, where it is burned and used to a considerable extent. By careful selection, blocks of good building stone might be taken from these limestones; but the strata being usually considerably shattered by disturbance, it would involve some difficulty to procure such material in large quantity,

and the same objection applies to its economic value as a marble, although it appears in many cases to be susceptible of taking a high polish.

A stratified drab-coloured clay occupies the banks of the lower reaches of the Exploits River below the Bishop's Falls, which appears to be well adapted for the manufacture of bricks. The river is navigable for small vessels or large boats as far as Jumper's Brook, where the tidewater terminates. Many parts of both sides of the main river below Jumper's Brook are well situated for the establishment of brick yards, and timber for fuel is everywhere amply abundant.

Specimens of the ores, and all other mineral substances of economic value, may be seen at this office, and further particulars regarding their distribution, &c., explained on the map.

I have, &c.,

(Signed) ALEXANDER MURRAY.

To His Excellency Colonel Hill, C.B.,
Governor of Newfoundland, St. John's.

CHAPTER XII.

REPORT FOR 1872.—AVALON PENINSULA—MR. HOWLEY'S SURVEY OF ROCKY RIVER, &c.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, 1873.

MAY IT PLEASE YOUR EXCELLENCY,—

I have the honour to submit for your consideration the following Report of the progress made upon the geological survey for the year 1872.

As much time and attention was required for the necessary equipment of the Museum, and subsequently for the arrangement of the geological collection, the field work for the season was restricted to the examination of certain parts of the peninsula of Avalon, and a portion of Trinity Bay, in order to be within reach of communication with St. John's, where these duties frequently demanded my presence. A topographical survey of the Rocky River and some of its tributaries was also effected, and has been laid down on a scale of 1 inch to 1 mile.

In accordance with an understanding entered into with your Excellency and Council in the early part of the year, I have been engaged for some time past in drawing up a general condensation of former Reports of progress, which, when completed, I hope will be found useful and instructive, as throwing some light upon the geographical character as well as the geological structure of this large and important island, hitherto almost unknown; and which may hereafter be of service in the development of her material resources. The condensed Report will be accompanied by a map, reduced from the most recent surveys of the coast, and from my own surveys of the interior, to a scale of 25 miles to an inch; and it is also intended to be illustrated by some vertical sections showing the geological arrangement across certain districts of country, and by drawings of the more characteristic fossil forms representative of the several formations. The map is now in the hands of Mr. E. Stanford, of Charing Cross, London, to be engraved

on copper. The sections and fossils I hope to have done on stone and in woodcuts at Montreal, under the superintendence of Sir William Logan.*

The inconvenience felt from the absence of any reliable plans of the topography of the country, whereon to delineate the geology, has been frequently dwelt upon in former Reports, and as this defect applies equally to the peninsula of Avalon as to the remoter interior, I considered it advisable to use all my available spare time in triangulating in the most prominent geographical features in the neighbourhood of St. John's, and in measuring the public roads by bearings by compass and paced distances. Starting from points of the coast fixed by the officers of the Admiralty survey, the points brought in by the triangulation were made to act as checks upon the paced distances, and the whole so far as done, when plotted to scale, produced a tolerably accurate and satisfactory result. This survey, while essential for the correct representation of geological detail, will be found very useful for other general or local purposes, and I intend, with the approval of your Excellency and Council, to extend such like surveys upon every convenient occasion.

The purpose of my visit to Trinity Bay was to ascertain as accurately as possible the boundary lines between the Huronian series of rocks and those of Primordial Silurian age, which formations had already been recognised by Mr. Howley in the year 1869, and partially traced out. Moreover, there being reasons to suspect the existence of mineral deposits which might prove of importance, acted as a further incentive to explore those regions with as much care as time and circumstances would permit. By following the shores of Trinity Bay south from Heart's Content, an opportunity was afforded for marking the junction of the two above-mentioned formations at various parts between that port and Tickle Harbour, where the outcrop of the upper series terminates in that direction; and, finally, for examining the subordinate rocks exhibited in the cliffs and mountains between Tickle Harbour and Rantem Cove.

The discovery of fossil forms in the Huronian rocks of St. John's, which were recently examined and described by Mr. Billings of the Geological Survey of Canada, is not only a new and interesting

* The map was published in 1873, and a second edition since that date.

geological fact, but is also of much value to the explorer while following out the structure, as it appears to mark a particular zone or horizon of the formation which is limited to the subdivision *d* of No 2 section of my Report for 1868.

The survey of the Rocky River waters was entirely trusted to Mr. Howley, after I had fixed the position of certain starting-points in the neighbourhood of Brigus, and I am pleased to have it in my power to inform your Excellency that the result of his work is highly satisfactory.

Drainage, &c., Central Avalon.

Of the numerous streams which flow into Trinity, Conception, Placentia, and St. Mary's Bays, and drain this great peninsula, three of the most important and most accessible fall into St. Mary's Bay. These are the Salmonier, the Collinet, and the Rocky Rivers. The former is probably the largest outlet for the waters of the eastern half of the peninsula, while the two latter, which run parallel to, and with but a narrow watershed between each other, drain a very large, if not the greater part of the central area. Several streams also discharge their waters into Trinity and Conception Bays, among the chief of which are the Dildo River of Trinity Bay, the Spaniard's Bay River of Conception Bay, and the two brooks which fall into the latter bay, one into the Northern and the other into the Southern Gut. With the exception of the Salmonier, the head waters of all these streams interlock with each other, in many cases being but short distances apart, but flowing in contrary directions. These waters take their rise upon an elevated plateau, extending lengthwise north and south over a large area, which is bounded on the west by the hill ranges of Placentia, and on the east by those of Conception Bay. The maximum height of those sources is between 300 and 400 feet above the level of the sea, from whence the rivers flow through narrow valleys enclosed between rounded ridges, mostly parallel to each other, which rarely attain an elevation over about 300 feet above the general level of the plain. A great part of this plateau consists of wide marshes or barrens, sparsely timbered or utterly bare, but there are also large tracts of country covered by forest, where the timber occasionally reaches a medium size. The facilities for canoe navigation, together with the central position of the

Rocky River, were inducements to select that stream for special survey and examination, of which the following is a description. The tabular form given below of the general courses and distances between marked points on that survey, commencing at Brigus Harbour, will be found of service in following the further detail.*

No.	Course.	Distance.		Height above High-water Mark.	Remarks, &c.
		mls.	chs.	feet.	
1	S. 61° W.	4	40	45	From sea-level at Brigus to Mackinson's farm, upon the Telegraph line.
2	S. 54° W.	2	60	..	Along the Telegraph line to end of portage to Battin's Pond.
3	N. 58° W.	0	34	351	To Battin's Pond, head of Hodge Waters.
4	N. 88° W.	0	78	288	From Battin's Pond to inlet of Level Pond.
5	S. 24° W.	3	35	280	From Level Pond, along a suite of lakes to the outlet of Brigus Grand Pond, at the crossing of Telegraph line.
6	S. 81° W.	0	35	246	From outlet of Brigus Grand Pond to inlet of Hodge Water Pond.
7	N. 87° W.	0	40	246	Across Hodge Water Pond to the outlet.
8	N. 82° W.	0	40	..	From outlet of Hodge Water Pond, across Nu-cool-minni-guloo Gospen.
9	S. 66° W.	4	70	..	From outlet of Nu-cool-minni-guloo Gospen, along general course of Hodge Water River to inlet to Taboo-minnigu-guloo Gospen.
10	S. 17° E.	0	56	..	From inlet to Taboo-minnigu-guloo to outlet of Tseist-minnigu-guloo Gospen.
11	S. 28° W.	1	13	189	From outlet of Tseist-minnigu-guloo Gospen to outlet of Wagedigulsiboo Gospen. The Big Barren River falls in on the south-east side of Wagedigulsiboo.
12	S. 19° W.	3	75	126	General course of river from outlet of Wagedigulsiboo Gospen to the forks of main brook of Rocky River.
13	South	7	37	..	To the falls of Rocky River. The top of the falls is from 20 to 25 feet above high-water mark. The average height of the cliffs below the falls is from 40 to 50 feet.

THE BIG BARREN BRANCH OF SAME RIVER, ASCENDING.

1	N. 85° E.	0	35	189	From outlet of Wagedigulsiboo to inlet of ditto from Big Barren Brook.
2	S. 27° E.	2	21	230	From mouth of Big Barren Brook, straight course up the stream, to outlet from Tusem Gospen.
3	N. 45° E.	1	70	233	From outlet of Tusem Gospen to inlet into Mestigue-gundaly Gospen; general course of river and ponds.
4	N. 34° E.	4	15	240	General course up Big Barren Pond to head, at end of portage to Hodge Water Pond.
5	N. 11° E.	0	48	246	Portage to south-west end of Hodge Water Pond.

* The courses given in the table are all from the true meridian, and indicate the straight directions and distances from one point to another without reference to roads, sinuosities of rivers or lakes, or irregularity of surfaces.

The waters of the Rocky and Collinet Rivers combined drain an area of about 100 square miles. The former is supplied through the channels of three main branches, namely, the Hodge Water, the Big Barren, and the Main Brooks, besides many tributaries of smaller size. The Hodge Water, which is the largest of these three branches, takes its ultimate rise in a small pond of about 2 acres area of surface called Battin's Pond, to which there is no visible inlet. From this source the stream flows westerly, as shown in course No. 4 of the table, into Level Pond, of about 4½ acres area, whence turning southerly, and occasionally opening out in a succession of small ponds, varying in size from 1 to 5 acres, it expands at length into Brigus Grand Pond, a long but narrow sheet of water, with a very irregular contour of coast, having an area of about 42 square acres. The next large expansion to the westward of this latter pond is Hodge Water, from whence this branch of the river derives its name, and which is situated as shown on the 6th course. It extends with many indentations on the eastern and western shores, and with several small islands dotting its surface, for about a mile and a half to the northward of course No. 7, and has a total area of about 37 square acres. The lower ponds indicated in the table upon the Hodge Water branch vary in size from about 2 to 13 acres area of surface. The Big Barren branch proceeds from a long narrow lake called Big Barren Pond, known also to the coast settlers as Ocean Pond, the northern end of which is, as shown in the table, within a little more than half a mile from the south-west end of Hodge Water Pond. The area of Big Barren Pond is nearly 100 acres, and there are three other expansions on the stream below before reaching the junction, with surfaces of from 2 to 8 acres. The so-called Main Brook joins the river at the termination of course No. 12. The ascent bears north-westerly for a little over a mile, at the end of which a brook of good size falls in from the northward, the main branch making a sharp turn southerly just above the junction for about a mile and a half, above which the upward bearing is westerly for a few miles, finally sweeping round to the north-west and north to the head waters. The course of this branch is represented to be very rapid generally, and to be interrupted by numerous falls.

The interlocking of the hydrographic features of the region already spoken of, is remarkable. The Collinet and Goulds Rivers

are said to take their origin within little more than a mile of each other, and between 2 and 3 miles to the eastward of Big Barren Pond, the former flowing southerly and emptying into St. Mary's Bay, near the debouch of the Rocky River; while the latter flowing north-easterly, discharges into the Southern Gut in Conception Bay. To the westward of the Rocky River on the other hand, the north flowing streams are the Dildo, Spaniard's Bay, and Northern Gut; of which the Dildo is the largest, and empties into Trinity Bay; and the south flowing, the western tributaries of Rocky River and the North Harbour River of St. Mary's Bay. The Dildo River, according to the description given by the Indians, rises within a little over 6 miles from the northern parts of St. Mary's Bay, and sweeping to the westward of the main brook of Rocky River, and passing on its course within about a mile from the head waters of the Spaniard's Bay River, finally falls into Dildo Arm. The Spaniard's Bay and Northern Gut streams rise in close proximity to each other, and flow in a general parallel direction to their outlets in Conception Bay. Upon the latter stream a large lake is represented to exist, known as Snow's Pond, which is situated about 2 or 3 miles north-west from the head of the Hodge Water system.

The general level character of the country on the eastern side of the Rocky River is favourable for the construction of a line of road, by which direct communication would be effected between St. Mary's and Conception Bays. The most direct line for such a construction would run on a course a little eastward of north from Rocky River bridge to the bend of the Big Barren Brook below the little lake called "Tusem Gospen," where the stream would be crossed, and thence north-easterly along the ridge which divides the waters of the Big Barren and Hodge Water branches, to tap the Telegraph line at the southern end of Brigus Grand Pond. Probably a communication might also be contrived between St. Mary's and Trinity Bays, by following the west bank of the main brook of the Rocky River and along the watershed of the Dildo, to the Telegraph line about 2 miles east of Spread Eagle Peak.

Although the general character of the country through which this survey runs, possesses no especial agricultural advantages, there are, nevertheless, many spots where the soil is rich and deep, and which might be reclaimed with advantage. Such,

for example, is the valley of the Goulds Brook, which falls into the South Gut on the north side of course No. 1 of the table; at the termination of which course the beautiful farm called "the Goulds," the property of Mr. Makinson, is situated. Independently of various crops yielded to a superior system of cultivation at this farm, I was informed that in the year 1871 there were no less than 500 tons of hay harvested, much of which was the indigenous produce of the low lands. Mr. Makinson is the possessor of from 2000 to 3000 acres of land in one block here, heavily timbered with spruce, fir, and yellow birch, over a large area. He maintains a large stock of well-bred cattle, and several horses, besides sheep, pigs, and poultry. There are other farms in the same locality, similarly circumstanced in regard to agricultural capability. After leaving the valley of the Goulds Brook, following the Telegraph line, as on course No. 2, the country becomes rugged, scantily timbered, and much encumbered by boulders; characteristics which obtain over the greater part of the surface on the eastern side of the upper lakes, including the Brigus Grand Pond, the Hodge Water, and Big Barren Pond. On the western side of Brigus Grand Pond and north from Hodge Water, there is an extensive tract of well-timbered country, and occasional spots capable of improvement, although usually more or less strewed over with boulders. The tract between the Big Barren Pond branch and the Hodge Water River is mostly marsh, with ridges of lighter timber of the usual varieties, until reaching the lake above Wagedigulsiboo, where the aspect of the country assumes a more fertile appearance, and the trees of the forest, although nowhere large, are of fair size and quality, consisting of pine, spruce, fir, and yellow birch. Much of the lower valley appears to be of good soil, especially near the forks of the Rocky main brook, where it consists of a deep sandy yellow loam, free from large boulders, and producing many stout sticks of spruce, &c., the best of which, however, wherever easily accessible, have been already culled out, and driven down the river to the settlements in St. Mary's Bay.

Distribution of the Formations.

The stratigraphical relation between the Huronian series of rocks with the group at the base of the Silurian system, hitherto

distinguished as Primordial, has been described in former Reports; and in that for the year 1868 a section is given of the succession and superposition as displayed between St. John's and Great Bell Island in Conception Bay. In the Report for 1870 a more detailed section of the Primordial Silurian group will be found, giving the sequence as nearly as could be ascertained at the time of the whole development of that formation, by coincidence of structure and superposition, as exhibited at the various localities of its distribution. Although further research may demand some modification of the structure represented in those sections, as well as in the contour of the boundary lines, as formerly described, they will be found sufficiently accurate as general reference for present purposes.

Since the date of those Reports a varied collection of fossils has been submitted to the palæontologist of the Geological Survey of Canada for examination, who recently sent me a very interesting account of his results, some of which will be quoted below.

It has already been stated at the beginning of this Report, that fossils have at length been discovered in the Huronian rocks of Newfoundland, they being also the first and only organisms yet identified within those ancient sediments. In a pamphlet entitled "Additional Notes on the Taconic Controversy," Mr. Billings thus describes this fossil, with a drawing of the same, taken from a small slab found at St. John's, Newfoundland.

Aspidella Terranovica, spe. and gen. nov.

"These are small ovate fossils, 5 or 6 lines in length, and about one-fourth less in width. They have a narrow, ring-like border, within which there is a concave space all round. In the middle there is a longitudinal roof-like ridge, from which radiate a number of grooves to the border. The general aspect is that of a small *Chiton* or *Patella*, flattened by pressure. It is not probable, however, that they are allied to either of these genera.

"Associated with these are numerous specimens of what appear to be *Arenicolites spiralis*, a fossil that occurs in a formation lying below the Primordial rocks in Sweden. Those fossils were first discovered by A. Murray, Esq., F.G.S., in 1866. Other specimens were collected by Capt. Kerr, R.N., Mr. Howley, and Lieut.

Robinson, R.N. They occur near St. John's in the Huronian. A more detailed description will be given hereafter."

The vertical range of this fossil, as far as yet ascertained, is limited to the slates (*d*) of the section (1868), which immediately underlie the Signal Hill group (*e,f,g*), and upon which the town of St. John's stands, where it was first discovered. In the course of our survey during the past year, similar organisms were found in equivalent strata in Trinity Bay, at several parts of the valley of the Rocky River, and at Ferryland, showing its wide range laterally; in some cases literally covering extensive surfaces of the rock with forms large and small, while in others they were found scantily sprinkled here and there in isolated individuals.

The exact line of contact between the Huronian and the more recent system of rocks in Trinity Bay, is often obscure and difficult to detect, being frequently concealed under a mass of worn débris, the common ruins of both; but the boundary is generally more or less distinctly indicated by a cut or depression of the land, where the escarpment of the newer system faces towards the land, and the strata of which it is composed dip towards the sea. The resemblance that exists in lithological character between the upper strata of the one and the lower strata of the other, is apt in many cases to be very deceptive, especially in the absence of organic remains, or where the exposures are of limited volume; and hence it is that the presence of the Aspidella is frequently of marked value as an indicator of the horizon, no forms bearing any resemblance to that fossil having ever been recognised in the rocks of the upper series, nor are they as yet known to exist in any of the strata, by which the slates (*d*) are underlaid. Taking then the horizon of the Aspidella slates as a starting-point in the section, we find them exposed at the head of New Harbour, in Trinity Bay, dipping from S. 30° E. to S. 45° E. < 30° to 35°. The slates are overlaid here by a few beds of greyish compact sandstone, with one of coarse grain or fine conglomerate, which may be taken to represent the base of the Signal Hill rocks, at *e*. In their northern strike these rocks, with a portion of the green and purple felsite slates below, the equivalents of *c* were recognised at the head of Hopeall Bay, dipping in a southerly direction; and at the rear of the harbour of Heart's Content, the division *c* is repre-

sented by a great mass of corrugated slates, which constitute the hill ranges. The southern strike of the same rocks would carry them to the head of Dildo Arm, near the exit of the river, but that arm was not visited, and the whole of the outer coast from Heart's Content to Tickle Harbour exhibit portions of the newer formation, to be mentioned hereafter.

The rocks of the western coast of Trinity Bay, between Tickle Harbour and Bay Bulls Arm, and which constitute the isthmus that joins the peninsula to the mainland, are classed in former Reports as of Huronian age, and all the evidence yet produced favour such a conclusion; still there are differences in lithological condition of a very distinct character, which must not be overlooked. These differences seem to have arisen from intense volcanic agency, which at various periods has affected the whole of the western part of the peninsula, to a much greater extent than is usually perceptible over the eastern parts. Huge intrusive dykes of various quality intersect the formation, and the strata are in large part made up of great beds of scoriaceous conglomerates or breccias, volcanic ash, and other igneous products interstratified with green or reddish felsite slates, and some cream-coloured, wrinkled, finely micaceous or probably talcose slates, which are slightly greasy to the touch. Similar slates to these last are mentioned in my Report for 1868, p. 152, as occurring in the neighbourhood of the La Manche mine, flanking the eastern and south-eastern sides of the hills of that location, which are of greenstone or porphyry. The run of the great intrusive masses varies from N. 20° W. to N. 30° W.; the strike of the stratification is N. 33° E., S. 33° W., the strata frequently folding over and dipping alternately northwesterly and south-easterly, but prevailing in the latter direction and usually at a high angle, in the neighbourhood of Rantem Cove.

A very remarkable mass of rock constitutes the cliffs from the outer or south-eastern point of Chance Cove to the western side of the Great Lagoon, usually called the Broad of Tickle Harbour.* Its position and run seem to indicate an intersection of the stratification being N. 20° W., and it displays a thickness at Chance Cove Head of from 10 to 12 chains. The prevailing colour is a reddish brown, but at many parts it becomes variegated

* Mentioned in note, p. 202, Report 1869.

by tints of green, bright red, and bright yellow. In mineral character it is everywhere very ferruginous, and the greater body of the rock is soft, splintery and fragile, without any signs of stratification. In some parts masses of serpentine are enclosed, and small quartz veins with thin strings of asbestos are frequently met with, while the cracks and fissures are often filled with steatitic clay. Epidote is abundantly distributed through the mass, and sometimes occurs in bands from 4 to 5 inches thick. Stains of the green and blue carbonates of copper were observed also at several places, and particularly on the cliffs near their termination by the long beach of the Broad.*

From Chance Cove Head the run of this mass carries it outside of the coast in the direction of Master's Head; and inside of the exposure at the same head, the rocks are concealed beneath a level tract and large basin or lagoon divided from the sea by a modern beach; but on the middle head between Chance Cove and Little Chance Cove, an altered breccious or conglomerate rock is exposed, the matrix of which is of a dark green colour, highly crystalline, and rather coarse in grain, which encloses numerous fragments of red jasper, white quartz, and other pebbles. The pebbles of this rock where seen in place are for the greater part angular and of small size, but it seems, judging from the character of the many boulders strewed around the point, to pass into a conglomerate, where the pebbles, many of which are of red and brown jaspers, are well rounded and often as large as a cricket-ball. In its southern run the mass dies down at the western corner of the long beach of Tickle Harbour, running apparently under the flats on the western side of the Broad about S. 15° E.; and there being a space of nearly a mile where the rocks are altogether concealed, between its last southerly exposure and the outcrop of the lower sandstones of the Primordial series, the relation or mode of junction remains still uncertain. The lowest exposures of the Primordial Silurian group come out at the points and along the shores on the eastern side of the Broad, and at the entrance by the settlement, where they consist of a set of sandstones and shales with irregular conglomerate beds, representing the division *a* of the section,

* The serpentine rocks alluded to here must not be understood to represent the serpentines of the Quebec group. The position they occupy indicates a lower horizon, and the mineral condition generally is dissimilar.

page 239, Report of progress 1870, of which the following is the succession ascending:—

1. Grey and greenish-grey sandstones, with some beds of a purple colour, in strata varying in thickness from 4 inches to upwards of a foot.
2. Dark grey or bluish arenaceous shales with one or two irregular beds of fine conglomerate, holding Huronian pebbles of green felsite slate, quartz, and trap, and beds of grey sandstone.
3. Reddish, purplish, and grey sandstones, generally in strong beds of from 8 to 12 inches, and with slaty partings.

(*a*) 600 or 700 feet. See section, Report 1870.

The upper members of this section hold the western shore of the peninsula, presenting a low dip to the eastward as far as Privet's Cove, where a set of variegated slates representing *b, c, d,* strike in front into the land. The strata above *a* to the top of *d* accordingly have a breadth here of a little upwards of a mile, but as the average dip does not exceed 15°, and they are affected by several gentle undulations, the total thickness probably does not exceed 700 feet. These are succeeded by a great accumulation of sandstones (*e*) with some massive beds of conglomerate, which occupy the greater part of the whole breadth of Tickle Harbour Point, and were estimated to contain a volume of about 1200 feet. The sandstones (*e*) are succeeded by a strong stratum of reddish limestone, with some red slate (*f, g, h*), altogether about 35 feet thick, which was found to cap the hill over Collier's Cove, in Collier's Bay; the summit of which was found by aneroid to be 315 feet above the level of the sea. This limestone is the centre of a trough, the underlying sandstones coming up from below it in Collier's Bay with a north-westerly dip, and afterwards folding over again in an anticlinal form, are repeated in the peninsula between Collier's Bay and Long Cove. The strata exhibited at Chapel Arm seem to include all the subdivisions of the section above *h* to *p*, but having been the seat of great disturbance from the intrusion and overflow of igneous matter is much faulted and confused. The black slates (*p*) here may be seen at many parts in broken, angular, and fragmentary masses of various sizes, crowded with crushed and distorted fossils caught in and fused solidly into the trap, giving evidence of intense igneous action at a period subsequent to the consolidation of the sedimentary deposit with its organic contents. The dykes which were seen to intersect

the strata bearing generally about south by west, are for the most part a coarsish crystalline greenstone, but sometimes passing into a rather compact basalt, which in some cases assumes an obscure columnar structure, the columns usually in a horizontal position, or inclined at a moderate angle. Much of the trap with which the fossiliferous slates are intermingled is vesicular, with cavities filled with white calc spar; and on the west side of the arm there is a rock characterised by containing a set of rounded masses resembling septaria, some of which are a foot or upwards in diameter. Northwards from Chapel Arm the black slates are displayed at Black Point, near Shoal Harbour, and finally at Highland Cove near Long Point, in each case underlaid by the variegated rocks; and at the latter place they exhibit a beautiful example of a sharp synclinal, where the mass of strata, upwards of 200 feet in thickness, is symmetrically folded and repeated within a distance of between 600 and 700 feet. The black shales at the base of this small exposure are crowded with broken fragments of *Paradoxides.* This exposure was observed by Mr. Jukes many years ago, and is represented in the drawn section, No. 5 of his Report, but he seems not to have detected the presence of the organic remains which at that distant date would have given a clue to the horizon. For further description of the structure in this region, see Report for 1869, pp. 200, 201.

On palæontological grounds, Mr. Billings is disposed in the meantime to draw a marked distinction between the upper strata of the section, namely, the subdivisions (*r, s*) and the lower members, in consequence of an apparent hiatus or break in organic development, between the Paradoxides beds and the fossiliferous strata of Great Bell Island in the Conception Bay section. The lower measures, that is from *q* downwards inclusive, he appears to regard as the equivalent of the lower Lingula flags of Great Britain, or the Menevian group of Salter and Hicks; while the upper parts contain forms in some degree considered typical of the horizon of Upper Potsdam.

Among the fossils Mr. Billings received from me for examination, taken from the lower measures, he has described and figured the following:—*Obolella miser,* nov. spe. from Chapel Arm; *Straparollina remota,* nov. spe. from Smith's Sound; *Hyolithes excellens,* nov. spe. from Smith's Sound; *Agraulos socialis,* nov. spe. from

Chapel Arm; *Agraulos strenuus*, nov. spe. from Topsail Head and Brigus; *Agraulos affinis*, nov. spe. from Branch; *Solenopleura communis*, nov. spe. from Chapel Arm; *Anapolenus venustus*, nov. spe. from Chapel Arm; *Paradoxides tennellus*, nov. spe. from Chapel Arm; *Paradoxides decorus*, nov. spe. from Chapel Arm; and a new genus, *Iphidea*, of which a species was found in the limestone of Topsail Head.

The fossils that have been examined from the Bell Island strata (*s*), together with some from the same horizon in Random Island, consist entirely of *Lingula, Cruziana*, and Fucoids. Among the latter Mr. Billings says "are some fine specimens of *Eophyton*, a genus first discovered on this continent by Mr. Murray." Those described are *Eophyton Linnæanum* (Torrel), *Eophyton Jukesi*, nov. spe., *Anthraria antiquata*, nov. gen. and spe., *Lingula Murrayi, Lingulella affinis, Lingulella spissa*, all nov. spe., and *Cruziana similis*.

Among the economic products of the regions described above, the ores of lead and copper were observed at a few localities, although in no case were the indications such as to warrant much extensive experiment in mining. Small cubes of galena occur in calcareo-quartzose veins in the rocks near Rantem Cove; and in the middle cove of Rantem a fault was observed running S. 84° W., on which an opening had at one time been made, among the refuse from which, some very small metalliferous fragments were found. It seems probable enough that these and such-like dislocations may be contemporary with, or belonging to the same system as the well-known lode at La Manche, in which case further examination along their run may discover places worthy of fair trial. Rumours are current amongst the settlers of the presence of lead ores near this part of the coast, but little reliance can be placed in such, as those who profess to be well informed, carefully avoid entering into particulars, especially as regards locality, when inquiries are made by a stranger, whose ulterior purposes are invariably looked upon with suspicion.

Near the entrance to the Tickle Harbour, the lower Primordial rocks are folded over in a gentle anticlinal form, the axis of which is penetrated by a set of veins partially calcareous, which contain specks and crystals of galena, copper, and iron pyrites in considerable profusion. The course of these veins would carry

them across the point into Tickle Harbour, a little east from the houses of the settlement, whence they would strike the mainland again near the point at the entrance of the narrows. The same bearing strikes across the Broad in the direction of the outlet of the river, at its southern extreme, where the junction of the older and newer formations might be expected to occur; a position where, should the veins be found to intersect, would be favourable for the development of the metallic ores.

The position of the slates which strike into the country at Privet's Cove places them about the horizon of the workable slates of Smith's Sound and Random Island, and it is quite probable that they occur in that locality; still, as unavoidable circumstances prevented the possibility of having that locality specially examined, no further particulars can be given in the meantime.

In my Report for 1870, at page 243, and under the head of economic materials, some remarks will be found upon the probability of the equivalents of the auriferous rocks of Nova Scotia being extensively developed in Newfoundland. Since that Report was written, Mr. Selwyn, the Director of the Dominion Geological Survey, has issued a Report, 1870–71, upon the gold-fields of the sister province, from which I quote the following paragraphs, page 269. Speculating upon the probable age of the auriferous rocks, Mr. Selwyn says:—

"My first impression of them, formed after personal examination last summer, and based upon mineralogical and stratigraphical considerations only, was that they represented the groups known in Britain as the Harlock grit or quartzite, and the Lingula-flag series; the former mapped as Cambrian by the British Survey, and the latter as the lowest member of the Silurian system.

"In confirmation of this view, I subsequently detected in the grey, sandy, and flaggy pyritous slates at the Ovens Bluffs, in Lunenburgh County, numerous specimens of the genus *Eophyton*, regarded by Mr. Billings as characteristic of the Primordial Silurian epoch. This genus is common in the sandy dark slates of the city of St. John, New Brunswick, in rocks hitherto referred to the Quebec group, on the Island of Orleans, and in *Newfoundland*. In all these localities it is accompanied by other well-marked Primordial Silurian forms, which further diligent search will doubtless also disclose in Nova Scotia."

Mr. Selwyn afterwards quotes Mr. Billings' remarks upon the distribution of the fossil *Eophyton Linnæanum.*

"In Sweden, where the *Eophyton* was first discovered, it occurs in the rock long known as the fucoidal sandstone, which immediately underlies the alum slate; this latter formation is undoubtedly the representative of the Lingula flags of Wales.

"In Newfoundland it was discovered by Mr. Murray on Great Bell Island, Conception Bay. It was there associated with two species of *Lingula*, a *Cruziana*, closely allied to, if not identical with *C. semiplicata* (a Lingula-flag species), and several fucoidal forms."

The circumstances recorded above then, undoubtedly tend to show that the equivalents of the gold-bearing rocks of Nova Scotia have a wide spread in this province, and the mineral condition at various parts of their distribution is such as to favour the probability that the precious metal exists; but this is still to be proved, and were it even established as a recognised fact, it by no means necessarily follows that the extraction of the metal is to be attended with remunerative success; more probably it might be found that the successful experiments were the exception rather than the rule, as they generally have been elsewhere. Upon this and kindred heads, Mr. Selwyn remarks, at page 277 of his Report, under "Causes of failure," thus:—

"Among the causes which may be considered as most prejudicial to the permanent and healthy progress of mining industry, the following may be mentioned. They are not in any way especially characteristic of Nova Scotia, but prevail more or less in every mining region of which I have any knowledge, particularly in the early years of their development.

"1st. The rash expenditure of capital in the purchase of mining rights respecting the actual value of which nothing is known with certainty.

"2nd. The hasty and inconsiderate erection of costly machinery for mining and treating the ores, before their quantity or probable value has been determined.

"3rd. The attempts frequently made to enhance the value of the stock by declaring dividends, sometimes paid out of capital, but often by means of a process commonly known as '*picking the eyes out of the mine*,' or in other words, selecting all the rich

material to secure a few high yields which are far in excess of anything likely to be the future average."

Rocks of Rocky River Survey.

The rocks of the region around Brigus have been described in the Report for 1868, p. 148. Their place in the section of that year is chiefly in the division *c* of the Huronian system, with some beds of *b* nearest the shores of the bay, where the unconformable Primordial rocks butt up against them. There is a wide interval of ground where the strata are concealed below a great accumulation of drift with many boulders, to the eastward of Battin's Pond, which is probably all occupied by the division *d*, and some loose fragments of slate were observed in the connecting brook between Battin's and Level Ponds, which resemble the Aspidella slates of that division, while on Level Pond the greenish-grey sandstones of *e* are brought in, presenting a dip S. 70° W. < 26°. On the Brigus Grand Pond, and the Hodge Water pond and river below, small sections of the same division (*e*) are exposed on the banks, usually dipping at a low angle to the northward, until within about 2 miles of the Taboo-minnigoo-guloo, where, upon a small pond off the right bank of the river, some loose fragments of slate, ripple-marked, and exhibiting the characteristic fossil Aspidella, indicated the probable position of *d*, while about a mile above Taboo-minnigoo-guloo division *e* is again repeated, dipping S. 70° W. < 11°. The sandstones (*e*) continue to exhibit themselves in a succession of gentle undulations until getting down to the junction of the main brook, where disturbance is suddenly manifested by the slates (*d*), showing a dip N. 93° E. < 75°, in close proximity and in front of some sandstones, supposed to represent the higher measures, dipping in the same direction, and indicating an overturn. The interior plateau thus appears to be the centre of a trough of Huronian rocks, of which the highest measures are the lower members of the Signal Hill sandstones. The exposures on the main brook above the forks, which are alternations of slate and sandstone, give further evidence of disturbance, and are occasionally intersected by greenstone dykes; the intensity of movement apparently increasing towards the westward, and probably connecting with the movements that have affected the rocks of Tickle Harbour and Chapel Arm.

The Aspidella slates with several beds crowded with the fossil are well exhibited below the forks, and continue to hold the surface, making a series of undulations, until getting about a mile below White Hart Brook, or about 4 miles above the falls at the outlet of the river, where they are succeeded by the green sandstones of *e*, which here are vertical, striking N. 36° E., S. 36° W. Farther down the stream they resume a more horizontal attitude, and may be seen at intervals dipping alternately towards north-west or south-east to within about a mile above the falls, where they rest upon the northern flank of an anticlinal axis of the Aspidella slates. The sandstones (*e*) are afterwards repeated on the south side of the anticlinal, and continue to present themselves at intervals to the falls.

In the Report for 1868, at page 161, a description of the rocks below the falls of Rocky River will be found; and it may be perceived that there was a difficulty at that time, as there still is, in determining the exact point of junction there between the upper beds of the Huronian and the lower ones of the Primordial series. There is, however, very little doubt that the shales seen at the mouths of the Collinet and Rocky Rivers are of the latter horizon, although late experience in the lithology of that formation would suggest a lower stratigraphical position than was supposed at the time that Report was issued.

Contrary to expectation, no outlying patches of Primordial age appear to be left in the country passed over by the survey; the whole mass, which probably at one time was united, from the southern to the northern bays, having been swept away by denudation.

From what has been said above, it may be inferred that the regions passed over by the survey, are not generally of a character to give much promise of the presence of metallic ores, although the more disturbed country farther west, being a continuation of the rocks of the isthmus of Avalon, may upon closer research be found to be metalliferous. The sandstones are in some cases well adapted for building, and in others would answer a good purpose for flags; but the material of the greatest economic value, as belonging to the formation at this part, is a hone-stone, which in texture and quality rivals the far-famed oil-stone of Turkey, for the purpose of sharpening the finer description of edged tools. It

is chiefly to be found near the base of the Aspidella slates (*d*), and near or at its junction with the inferior member (*c*), where, by careful selection, it might be produced to almost any extent.

In a former Report a suggestion is offered of the probability of the slates at Ferryland proving to be an outlying patch of the workable Primordial slates of Trinity Bay, but further investigation has shown that such is not the case. The slates of that region are of Huronian age, belonging to the horizon of *d*, (section of 1868), near the base of a set of slates, covered on some surfaces by *Aspidella Terranovica*, which are again overlaid towards the coast by the Signal Hill sandstones. The lower beds present a cleavage, independent of the bedding, at right angles to the planes running on the same strike; but the stone is very brittle, and not generally well suited for any economic purpose.

I have the honour to be,
Your Excellency's most obedient servant,

ALEXANDER MURRAY.

His Excellency Col. S. J. Hill, C.B.,
Governor of Newfoundland, &c. &c. &c.,
St. John's.

CHAPTER XIII.

REPORT FOR 1873.—DESCRIPTION OF THE COUNTRY SURROUNDING ST. GEORGE'S BAY, DIVIDED INTO THREE AREAS — DISTRIBUTION OF THE CARBONIFEROUS FORMATIONS IN THE SAME REGION, &c.—LETTER TO SIR STEPHEN J. HILL, DATED MARCH 9TH, 1874.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, NEWFOUNDLAND, *March 9th*, 1874.

MAY IT PLEASE YOUR EXCELLENCY,—

In the letter dated the 3rd of October last, which I had the honour to address to your Excellency, an abstract was given of the proceedings of the Geological Survey, during the summer and autumn of 1873.

The purpose of the season's exploration was especially to ascertain the extent and productiveness of the coal-field of St. George's Bay; in following out which inquiry I have been enabled to determine, with considerable accuracy, the general structure of the Carboniferous formation as developed in Newfoundland, and its relation to the subordinate older systems. Several new and important facts were also ascertained regarding the distribution of the Lower Silurian series of formations which are extensively displayed over the northern part of the district; but minute particulars regarding these, I shall defer giving for the present.

The defects and inaccuracies of the old coast charts I took occasion to mention in the letter already alluded to; which, together with the absence of any topographical detail whatever throughout the region explored, involved the necessity of making the surveys spoken of through the same medium. These surveys are plotted on a scale of 1 mile to 1 inch; and on the map I have drawn in the geological features, to show the position and relation of the different members of the Carboniferous formation, I have particularised the areas over which workable seams of coal are most likely to occur. This map is further reduced to a scale of 4 miles to 1 inch, and on the latter some surveys of

former years are also entered, the whole comprising the country on the west side of the meridian of 58° W. longitude, and south of the Bay of Islands to Cape Ray.

Tracings of these maps I have now the honour to submit to your Excellency with this Report, trusting that the information contained therein may, in some degree, encourage a spirit of enterprise and progress, and lead to the development of these fine regions.

The map on the smaller scale, I intend, with the approval of your Excellency in Council, to have lithographed and published, without delay, as the facts recorded thereon will probably be of themselves sufficiently intelligible for all immediate purposes.

Geographical and Agricultural.*

The Long Range mountains, which terminate in their southern course at Cape Ray, run in a north-easterly direction, and in a moderately straight line towards the head of the Grand Pond, and on to the Humber River below Deer Pond; their north-western flank forming the boundary of the area to which the attention of the Survey has chiefly been directed during the late season. The whole region, roughly estimated, contains an area of about 1824 square statute miles, and may be thus subdivided:—

		Sq. miles.
1st area.	South-east side of St. George's Bay, inclusive of the Codroy valleys	816
2nd „	Country between the west coast and the Long Range mountains, south of the Bay of Islands, to the north shore of St. George's Bay	720
3rd „	The Port-a-Port peninsula	288
		1824

The main coast line of St. George's Bay, between the Little Barachois in Flat Bay and Fishel's Brook, is for the greater part composed of abrupt banks of modern drift, rising to an elevation which varies at certain points, from 100 feet to upwards of 180 † feet in height. Farther south the drift banks are interrupted by sections of the Carboniferous rocks jutting out through

* All courses and bearings are taken from the true meridian.

† Robinson's Head reaches to 275 feet.

them, still maintaining great uniformity of elevation; but southwestward of Crabb's Brook, the rocks almost exclusively occupy the coast to Cape Anguille. Between this south-western part of the coast and the Great Codroy River, the character of the country differs essentially from that farther to the north-east, in being mountainous, forming a range which derives its name from the Cape at its western extremity. This range is shaped somewhat rudely to resemble an isosceles triangle, the base of which is the coast between Cape Anguille and Codroy, while the apex reaches to a point midway between the coast and the Long Range mountains, and within about 3 miles of the course of Crabb's Brook, where it is locally known as "The Highlands" of St. George's Bay. The highest summits of the Cape Anguille range reach an elevation of 1200 feet or more, and are in many parts abrupt, and even precipitous; but they materially differ in their contour and general aspect from the rugged masses of the Long Range, by being smoothly rounded in form, and by carrying more or less vegetation to the highest parts. Innumerable small streams, which take their rise from lakes and lakelets among these mountains, pour their waters in picturesque cascades over the lofty cliffs which bound St. George's Bay; while many more flowing in the opposite direction join the waters of the Great Codroy River, or fall into the sea between its outlet and Codroy Island.

North-eastward from the terminating point of the Cape Anguille mountains, the whole country between the coast and the Long Range is of a flat or undulatory character, densely covered with forest-trees, except in such parts as have been swept by fire or occasional tracts of marsh. The trees of this forest consist of white and yellow birch, spruce and balsam fir, poplar and tamarack or larch. There is however, little or no pine. The only parts where that timber was observed to grow were on a few spots near the banks of the Flat Bay Brook, and an occasional spot in like manner in the valley of Fishel's Brook. Much of the timber of this great plateau is very large. Trees of yellow and white birch are frequently met with, and particularly on the river flats, having a diameter of 3 feet, and even more, many of which are tall and straight, resembling the hard-wood forest-trees of Canada; spruces, balsams, poplars and tamaracks also reach a maximum size, and seem to be of excellent quality. The ground is often

covered densely by a creeping bush, a species of yew, generally known as ground hemlock in Canada, where it abounds; all amply testifying to the excellence of the soil upon which they grow.

The higher parts of this plateau rarely exceed from 300 to 400 feet above the beds of the streams.

The drainage is mainly effected through the channels of the rivers surveyed and represented on the map, namely, the Little Barachois and Flat Bay Brooks, which fall into Flat Bay; the Fishel's, Robinson's, Middle Barachois, and Crabb's Brooks, which empty directly into the Great Bay: and the Great and Little Codroy Rivers, which fall on the southern side of Cape Anguille. The two former and the two latter of these streams, with their valleys, were described in my Report for 1866, while the surveys of the remainder were accomplished during the late season's investigation. All these streams take their rise among the barren wastes of the Long Range mountains, but the lower reaches of each, for distances varying from 12 to 20 miles, flow through richly-wooded and fertile valleys intersecting the plateau just described. These valleys and much of the higher lands now primeval wilderness appear to be in nearly every respect well adapted for agricultural settlement. By deducting the tract occupied by the Cape Anguille range of hills, amounting to 256 square miles, which is too high and too steep for ordinary tillage, although well suited as runs for sheep or cattle, the remainder of the block, viz. 560 square miles, is certainly to a large extent reclaimable, and there can be but little doubt that the construction of roads, which must necessarily be the consequence of occupation, together with the clearing of the forest, will lead to mineral discovery of vast importance to the colony.

With the exception of the Codroy Rivers, which flow in a valley between and parallel to the two ranges of mountains, the Long Range on the south-east and the Cape Anguille range on the south-west sides, the courses of the streams run nearly at right angles to the strike of the mountains, bearing generally a little to the northward of due west. Near the parts where they debouch from the mountain gorges, there are usually long stretches of still water lying at an elevation of between 400 and 500 feet above high-water mark; below which they rush rapidly with few intermissions of steady,* although without any falls above 2 or 3 feet in height, for

* A common local term for still water.

the remainder of the distance to the sea. In their meanderings, the banks of these rivers display alternately bold rocky cliffs and low alluvial flats; the former occasionally, as in Fishel's Brook, rising perpendicularly from the river to the height of 100 or 150 feet. In common with all mountain torrents, these streams rise with wonderful rapidity every rainfall; but the supply is as readily exhausted, and the normal state is shallow, rendering canoe navigation always precarious and often impossible. Water power, for the purpose of driving machinery, could be obtained at almost any point desired; the low-lying flats offering every facility for building or mill sites.

Our second geographical area forms a nearly rectangular block, bounded on the west by the coast of the mainland of Port-a-Port Bay; on the east by the valley of Harry's Brook and the marshes which flank the mountains of the Grand Pond; on the north by the southern coast of the Humber Arm; and on the south by the north shore of St. George's Bay. Besides a considerable portion of the coast, Harry's Brook and a part of the Rivière Blanche were surveyed.

A very large portion of this area is mountainous, and among the mountains are some of the highest summits I have yet met with in the Island.* Viewed on a bright summer's day, from the deck of a vessel, the beauty of the scene presented by the land features upon all sides is very impressing; yet at the same time a conviction will almost inevitably arise that, after all, such beauty, in a material sense, is a delusion, and that the whole region is nothing more than a vast inhospitable desolation. Such, however, upon nearer inspection, proves to be very far indeed from being the case. Tracts of considerable extent upon the coast, and nearly all the valleys of the principal streams, bear a soil of the most fertile description, which is even already shown by the few and rudely cultivated spots here and there, where the produce in grass, green crops, and even cereals, are all first class, both in quantity and quality. And this in a country where there is no evidence of the existence of a plough, a harrow, or a wheeled vehicle of any kind whatever!

* I allude to the "Blow-me-down" hills, which were found by triangulation in 1866 to be 2085 feet high, where they rise sharply over the Humber Arm. There are probably higher peaks inland.

Indian Head is a bold rocky promontory on the north side of St. George's Bay, being the prolongation of an isolated or detached range of Laurentian mountains which protrudes through the level Carboniferous country by which it is surrounded. The coast on either side of this promontory is low and shelving, with broad beaches of sand and gravel, which extend to the eastward as far as the main gut of St. George's River; and to the westward to the Rivière Blanche. Southward of the gut the coast line is also low, with boggy banks to the outlet of the Little Barachois. Westward from the Rivière Blanche the shores are bounded by abrupt banks of stratified drift, with occasional small protruding outcrops of the rocks up to and around the point on the eastern side of the Gravels. The east coast of Port-a-Port Bay, north from the Gravels, presents abrupt rocky sections of moderate height, succeeded by long stretches of low beach and boggy banks, with wide lagoons at the entrances of the small streams, until getting near to Bluff Head, where the cliffs rise grandly to the height of 1000 feet, almost vertically from the water's edge.

At no great distance back from the coast north of the Gravels, a range of Silurian mountains rises to an average height of from 900 to 1000 feet, which, striking obliquely into the interior on a bearing about N.N.E., forms the watershed which divides the west-falling rivers from those of St. George's Bay. The most important of the former of these are Fox Island Brook, Louis' Brook, and the Coal * Rivers, but there are innumerable streams of smaller dimensions to be seen trickling down the sides of the mountains, which uniting in the deep gorges pour their accumulated waters in an impetuous torrent into the lagoons, or come tumbling over the steep cliffs into the sea. Our time would not permit making surveys of any of these rivers, but from the evidences visible at their outlets, and such information as could be derived from the inhabitants, there can be little or no doubt that large tracts of extremely fine land extend up their valleys for many miles. The richness of the soil at this part of the coast is probably due to the calcareous material derived from the adjacent mountains, together with the disintegration of the trappean rocks of which the subsoil is composed. We were surprised to perceive that the little Fox Island lying out in the bay, which,

* Afterwards called Serpentine River.

as seen at a distance, was conceived to be a mere barren rock, was covered over three-fourths of its area with a soil of the richest description, and that the gardens of the two families of poor fishermen who inhabited it were producing crops of potatoes, peas, and hay, which for luxuriance and vigorous growth, although the mode of culture was of the very rudest, could hardly be surpassed.

Rivière Blanche is a stream which falls into St. George's Bay about 3 miles north-west from the Indian Head promontory. The name given to the stream is by the request of the Rev. Thomas Sears, V.A. (who takes a great interest in the country, and this part of it in particular), in compliment to the members of a family called LaBlanche or White, who have been occupants of the lower part of the valley for many years, the original patriarchal squatter of whom is still alive, with children, grand-children, and great-grand-children, amounting in all to 178 souls, all of whom have been raised upon the soil. The river was measured about 6 miles along its course. A block of rich flat land, supported upon members of the Carboniferous series, is shut in, as it were, by the Silurian mountains on the north and west, and by the Indian Head range on the east, which is chiefly drained by the Rivière Blanche aforesaid, and Romain's or Kippen's Brook. The area of the block is between 30 and 40 square miles, or about 22,400 acres. The whole of this area (excepting the small clearings at the mouths of the streams) is densely covered with forest of large and vigorous growth, with abundance of yellow birch, spruce, fir, and other trees, but scarcely any pine. The surface of the land slopes gently upwards towards the mountains, the higher parts apparently seldom much exceeding 500 feet above the sea. The river is rapid throughout, with short intervals of still water; the rise upon the stream to the end of our measurement being 372 feet.

The sources of Harry's Brook take their rise about 10 miles south-west from the outlet of the Humber River, where it joins the southern arm of the Bay of Islands, upon the southern flank of the mountains which constitute the watershed. Two branches, of which the larger and main stream is the eastern, flow nearly parallel to each other, each having lakes or ponds at the head, into a fine expanse of water called St. George's Pond; whence the

general course of the stream is south-westerly, although with many sinuosities, to its outlet near the main gut of St. George's River. At the head of the eastern branch there is a lake called by the Indians Eh-quodeg-a-weh Gospen, which, according to the register of the aneroid, reaches the altitude of 824 feet above the level of the sea, and has an area of surface amounting to upwards of 9000 square chains, or nearly 2 square miles. A straight line S. 69° W., 4 miles from the outlet of this lake, reaches the north-eastern angle of St. George's Pond. The other upper branch flows from a suite of small lakes, the largest of which is known as Little St. George's Pond, the straight course being S. 63° W., 3½ miles into the north-west angle of St. George's Pond. The head waters of this last branch are divided by a mountainous watershed of not over 2 miles, from the head waters of the Coal River. The extreme length of St. George's Pond is about 7 miles, and its average breadth somewhat exceeds 1 mile, expanding at parts to fully 1¾ of a mile. The area of surface is consequently a little over 7 square miles, or say 45,000 square chains. About 3 miles below the outlet of St. George's Pond the river is joined on the right side by a stream of considerable volume, flowing from the westward, which probably takes its rise among the Indian Head hills; and at about 3 miles farther down by a straight course, it is joined on the left side by another tributary called Spruce Brook, which heads to the eastward within a mile of a stream also called Spruce Brook, described in my Report for 1865, which falls into the Grand Pond. There are several other smaller tributaries of less importance.

The valley of Harry's Brook, above the western fork, is rugged and barren for the greater part, and much of it hilly or mountainous; the mountains north of St. George's Pond reaching an elevation of 1556 feet above the level of the sea. Below the junction of Spruce Brook patches of good land begin to appear, chiefly on the right bank; and back from the lower reaches on the same side, there is a broad tract of very good country. The islands and low banks near the outlet are of the best of soil for grass meadows. To the south-east of Spruce Brook nearly the whole country is spread over by vast marshes which extend up to the flanks of the hills on the south-west side of the Grand Pond.

The third geographical area, or Port-a-Port peninsula, is still

only very partially surveyed, and requires much more extended investigation. The topography of this part, represented on the map, is a reduction from a French chart, which, however, seems only to be a modification of the old surveys of Captain Cook, and bears the date of 1784. Much of the peninsula is high and hilly, with rocky precipitous cliffs facing the sea on nearly all sides, but especially on the south and west coasts. There are, however, numerous patches of very fine land, and particularly around the shores of the Western Bay, where it extends nearly uninterruptedly up to the foot of a conspicuous and isolated hill called Round Head, which rises abruptly over the north-western shore. As the mineral indications observed seem to favour the probability of the peninsula becoming a mining district in course of time, these patches of available agricultural land can scarcely fail to become of great value.

The vast importance of these regions as an agricultural country, setting its probable mineral value aside altogether, may in some degree be understood by supposing the whole available area to be blocked off in lots of 100 acres each, and each lot to be occupied by one person; there would then be 3584 settlers on the south-east side of St. George's Bay; 224 on the Rivière Blanche and Romain's Brook block; and 320 (at least) upon all the remainder. If we further suppose that each settler has a family of five members, there would then be a population of 20,640 souls. To establish such a settlement is surely a matter well worthy of public consideration; but to do so in a manner that will be mutually of advantage to the occupiers and to the country at large, great care must be taken that the land is subdivided systematically, and on the same general plan, whether the purpose of the holder of property be mining or agriculture. In this connection I need only once more refer to my answer to query 4, put by Mr. Pinsent, President of the Select Committee of Inquiry, to be found on pages 38, 39 and 40 of the Report, dated 1869; where a system or principle is propounded which I see no occasion materially to alter or modify.

One of the greatest difficulties to be contended against in settling and advancing the St. George's Bay country is the lack of harbours, or places of security of any kind for vessels to take shelter, or to land and embark cargo. The only harbour in all

the region, properly so called, is at Sandy or Harbour Point, at the entrance to Flat Bay, where vessels of all sizes can find a safe and commodious anchorage. The bays of Port-a-Port are no doubt also safe from heavy seas and strong winds to a certain extent, being more or less landlocked on all sides, but the approach to the bays from without is difficult and somewhat dangerous; the long low points, namely, Long Point and Shoal Point, being scarcely perceptible in thick weather, or in an ordinarily dark night. Small vessels find harbour during the summer months in the little cove on Codroy Island, and larger ships often anchor in the roadstead outside, but neither can be admitted as *good* at any time, and in the stormy months of autumn, winter or spring, are simply impracticable. Small vessels and boats can, at the same season, find access into many of the Barachois or Lagoons, at the mouths of the larger brooks by entering at high tide; but either exit or entrance during strong winds is frequently impossible, and a delay of a week is by no means a rare occurrence.

Were the country settled and mining operations going on, it appears to me that a canal might be cut through the gravels of Port-a-Port with immense advantage. The two bays are there only divided by a beach not much over a quarter of a mile across altogether, the greater part of which is occupied by a salt-water pond, which rises and falls with the tide. A breakwater built out from the western point on the St. George's Bay side, would secure that part from the violence of south-west or southerly gales; while very little artificial protection would be requisite on the Port-a-Port side, to render it safe as an anchorage, and from the wash of the sea. By such a construction ingress and egress would be easily effected at all times, thereby often avoiding the long and tedious voyage round Cape St. George.

But a matter of, if possible, even more importance to the welfare of a young agricultural settlement than harbours, is land communication by means of main lines of road; and I would strongly urge the propriety of reserving certain portions for that especial purpose. On the map, it will be seen, a "proposed line of road" is indicated, which if opened out might become a part of a main leading artery throughout the province; and probably may be found hereafter to be the line of all others best adapted

for the construction of a railroad. Leaving the shores of St. George's Bay at the Seal rocks, nearly opposite to Sandy Point, the road would follow nearly a straight line to strike the still water of Flat Bay Brook, below the Cairn Mountain; whence it would strike in a westerly direction, running nearly parallel with the mountain range and crossing the several streams near their still expansions, up to Robinson's Brook, where the valley being open and wide, it would bear off to the south-eastward, cross the mountain range, and finally slope downwards into the valley of the Exploits. From Robinson's Brook the road might be extended south-westerly to strike the valley of the Great Codroy River near its upper forks, and thence down the same valley to the sea.

There are many reasons for preferring this line as a leading artery to any other. In the first place, the slope is very gradual all the way, and some parts are on a dead level, until turning up the valley of Robinson's Brook, where the rise is less abrupt, and the valley more open, than at any other approach to the Long Range mountains, and these *must* be encountered *somewhere* if a main road is to exist at all. In the second place, an important item of expense in such structures, as bridges, viaducts, and other buildings will be greatly lessened, and moreover be more permanent than elsewhere; as the force of the great masses of ice which are borne down by the turbulent torrents would render all structures insecure that might be thrown across them farther down, unless by suspension, which would involve generally, particularly at the outlets of the streams, too wide a span to be recommendable, if practicable. In the third place, the line indicated would pass through a rich and fertile country in all directions, with the exception of the crossing over the belt of mountains, and would form a base of communication from which tributary roads might be extended to every available portion of the Island.

As regards local roads, particularly within the region of the first area, I need only repeat the words used on a former occasion, and often quoted since, to be found on the 39th page of the Report of the Select Committee. Let parallel divisional lines be drawn at right angles to the general trend of the coast at 1, 2, 3, or 4 miles apart, and produced until they tap the main line near the foot of

the mountains; let these lines again be intersected by other lines at right angles at certain intervals, thereby subdividing the land into rectangular blocks, which can be further subdivided in the same manner, according to the purposes or requirements of the proposed occupiers.

That some systematic plan such as the above, and as I have frequently had occasion to recommend before, must eventually be acted on, I feel very confident; otherwise all attempts at settlement will be frustrated, the holders of licences and grants will be involved in ceaseless litigation, and progress and civilisation will be retarded for years to come.

The Carboniferous Series of Newfoundland.

By a glance at the geological map of Canada it will immediately be observed that a vast area of the provinces of New Brunswick and Nova Scotia is spread over by members of this series; and further that the geographical position, where similar measures have been recognised in Newfoundland, is suggestive of the latter being the prolongation of a great elliptical-shaped trough extending from the former, the centre of which is concealed beneath the waters of the Gulf of St. Lawrence. It may also be perceived that while in New Brunswick the formation extends in a uniform unbroken sheet over the surface, it becomes broken and patched in Nova Scotia and Cape Breton. The symmetry of the ellipse, moreover, will be seen to be broken near its centre at the Magdalen Islands, where a part of the lower members of the system come to the surface, indicating the axis of an anticlinal fold, bearing in the direction of St. George's Bay. Proceeding from the westward, this fold would thus appear to be the first of a series of disturbances, which increase in frequency farther east, and which are intensely developed in Newfoundland. The contemporaneity of the Carboniferous rocks of the latter with those of the mainland is manifested by the same want of conformity with the older and supporting formations, and the almost exact resemblance which obtains in mineral, lithological, and fossil characters throughout the stratigraphical sequence, from the base upwards; but the accumulation in the Island would appear to be in considerably less volume than on the

mainland; and so far as our researches will permit the expression of opinion, it seems that it is in the upper members that the Newfoundland series is principally wanting. The south-eastern boundary of the formation may be traced from a little way north of Cape Ray along the north-west flank of the Long Range of Laurentian mountains, up to the extreme head of St. George's Bay, where, although concealed from view, it was supposed to cross over, and making a further stretch beneath the marshes to the northward, finally sweeps round in a westerly course and crosses Harry's Brook below Spruce Brook, where it rests upon strata of Lower Silurian age. Its course westward is then interrupted by the protrusion of the labradorites of the Indian Head range; but westward from that range the whole of the flat country is supported by Carboniferous rocks, which rest upon the upturned edges of Lower Silurian strata, displayed in the mountains which bound the plain, and on the coast of Port-a-Port Bay. Irregular patches of the formation are then found farther west in Port-a-Port Bay, and a strip is displayed along the outer coast of the Long Point peninsula of the same, while to the northward it is recognised in the valley of the Coal River.

For convenience in describing the distribution of the series, I have divided it into five members, distinguished by letters, from *a* to *e*, inclusive, the general vertical section of which is given below, in descending order. Corresponding letters will be found on the map.

	Feet.
e. Green and red sandstones, with brown and black carbonaceous shale, and brown and drab-coloured clays. Fossil trees and flora abundant. Coal seams with underclays holding *Stigmaria*	1000
d. Brown and reddish sandstones and conglomerates; brown, blackish, and greenish micaceous, and arenaceous shale. False bedding in sandstones and ripple-marked surfaces frequent. Fossil plants, among which *Sigillaria* and *Calamites* are frequently met with. Thin seams and nests of coal	2000
c. Variegated red, green, and drab-coloured marls; red, green, and brown sandstones, which are frequently calcareous; beds of bluish and grey limestones, some beds apparently magnesian, and many contain a profusion of organic remains, marine shells, &c., carbonised plants in the arenaceous strata. Salt springs frequent	2000

	Feet.
b. Great masses of gypsum, with green and brown argillaceous shale; red marly shale; bands of black or dark grey limestone, and occasionally jet-black shale	150
a. Very coarse conglomerate composed of great boulders and pebbles of Laurentian and Silurian rocks, cemented in a matrix of greenish-coloured sand; great lenticular intercalations of sandstone with coarse arenaceous shale; large fragments of magnetic iron ore; passes at the top into a brownish-grey flaggy sandstone with brown and greenish shales which underlie the gypsum	1300
Total	6450

The lowest division (*a*) forms the axis of a broad anticlinal, which, commencing at Cape Anguille, runs nearly parallel with the Long Range mountains, and with the trend of the sea-coast, up to and across the main gut bearing northwards on the east side of the valley of Harry's Brook. This conglomerate is of very irregular thickness in the different parts of its distribution, and appears occasionally to be absent altogether. At Cape Anguille it was seen only on the south side, associated with beds of dark grey sandstone, in which some few tangled bunches of vegetable remains were observed, with black shale and some bands of black limestone, the latter occasionally striped with thin seams of snowy gypsum. The Cape Anguille mountains have as yet been only partially examined, and further investigation is necessary before the structure can be given with precision; but the inference to be drawn from the facts ascertained is, either that the broad belt they occupy consists of a series of sharp contortions of this division, or that the higher parts are protrusions of the unconformable lower formations, which probably in this case are of Lower Silurian age. At the Middle Barachois Brook the division sinks below the succeeding band (*b*), which is there spread widely over the surface; but it rises again at Robinson's Brook, about 3 miles up its course, and continues to occupy its banks for nearly 2 miles farther, folding gently over; showing a dip on the north side S. 65° W. < 15°, while on the south side it dips S. 19° E. < 13°. The thickness exposed here would appear to be nearly 1300 feet. But the best exhibition of the division is at Fishel's Brook, where it rises from beneath the great masses of gypsum about 2 miles up the stream, in vertical cliffs from 100 to 150 feet high, which form the banks for upwards of a mile and a

half. At the junction with the gypseous mass on the northern side, the dip is N. 21° W. < 21°, upon a set of greenish-grey flaggy sandstones, some layers of which are slightly calcareous; and those are immediately underlaid by the coarse conglomerates, which maintain a nearly uniform dip, N. 42° W. < 13°, for about a mile upwards, where the strata become horizontal. This would give a thickness of about 1179 feet. The conglomerates hold this horizontal attitude for nearly half a mile, and then bend over gently, and present a moderate but irregular dip S. 6° E. At a sharp bend of the river here the strata were observed to be affected by a set of small parallel dislocations running S. 41° W., with the upthrows upon the south side, and underlying south-easterly, the value of which varies from 15 to 20 feet. At each of these faults there are small trickling springs of saline water; and at the end of the section, about half a mile farther up the stream, there is a strong saline spring, which bubbles up through the soil, a little way back from the right bank of the river.

The sources from whence the materials of this conglomerate have been derived are very obvious; and it is interesting to observe the exact resemblance which exists between the solidly cemented masses of the rock and the superficial boulders and pebbles recently brought down by ice and the stream from the same mountains, which gave origin to the base of the Carboniferous formation in the same locality. The greater proportion of these boulders and pebbles are derived from Laurentian rocks, the former often 2 or even 3 feet in diameter; but there are many of Lower Silurian age also of very large size, consisting of bluish-grey limestones, which frequently exhibit characteristic fossils, chiefly fucoids, and occasionally univalve and bivalve shells and corals. The larger boulders are invariably rounded, and among them there are frequently to be found great masses of magnetic iron. Among the smaller and medium sized rocks are fragments of white crystalline limestone, slate, trap rocks, and red jaspers.

The same division (*a*), with its characteristic conglomerate, is again largely displayed farther north, on the banks of the Flat Bay Brook, where it appears to spread out over an area of about 4 miles in width, making a series of undulations, up to within a short distance of the mountain range, where it is turned up with a reverse dip, against the great fault of which mention was made in

my Report for 1866. Northwards from Flat Bay Brook the strata are concealed, the surface of a wide extent of country being flat, covered with forest or marsh; but the conglomerates were recognised on the banks and bed of Harry's Brook, 3 miles below Spruce Brook, in a nearly horizontal attitude, striking towards the Indian Head mountains.

The conglomerate of the division is not very distinctly displayed in any part of the western or third area, except at Red Island off the coast, north from Cape St. George, which is entirely composed of it, and where it lies in nearly horizontal strata, with a gentle dip, of not over 100 feet in a mile, to the northward; the cliffs on the southern side being about 200 feet high, and those at the northern extreme about 100 feet, the beds traceable from end to end. In 1866 a conglomerate was observed upon the mainland, nearly opposite to the island, to come against the Silurian limestones by a fault, which was supposed at the time to be of Carboniferous age, and the impression was further confirmed by the presence of some Carboniferous limestone fossils near the spot, which seemed to have fallen from the cliffs above; but the unfortunate accident, by which I was temporarily rendered helpless, prevented the thorough examination of that part which is still required. From information received during the season, there appears to be a strip of Carboniferous rocks running along the coast of the Long Point peninsula, which butts up against Lower Silurian strata, indicating a fault which would run in nearly a straight line from the cliffs where the fossils were observed on a bearing about north-east towards Long Point.

The succeeding division (*b*) represents the position of the great masses of gypsum which are developed more or less, and in many instances in enormous volume at one part or another throughout the country, wherever the Lower Carboniferous rocks are exposed. In my Report for 1866, the division is thus described:—

"The coast southerly from Codroy Island displays cliffs of red and green marls, with thinnish beds of black or dark brown, sometimes nodular limestone, associated with which are vast masses of gypsum. The strata very much corrugated, contorted, and broken, especially at the immediate contact with the gypsum, which sometimes contains great fragments of beds of limestone, enclosed within the gypseous paste."

These gypseous measures are then represented in the same Report to be repeated by a succession of sharp folds, and were seen to cross at Ryan's Brook with the associated limestones, striking up the valley of the Codroy River on the south-east side of the Cape Anguille mountains. On the northern or north-eastern side of the great anticlinal, masses of gypsum with limestone and red and green shales are known to run out near Cape Frior, but seem usually to keep inland, flanking the mountains at the Highlands, thence striking north-easterly through the flat lands of Crabb's Brook, cross the Middle Barachois, where, spreading over a considerable area, they form a flattened dome, concealing the subordinate conglomerate. In its northern extension the division was seen in the bed of Robinson's Brook following the course of division *a* on the northern side of the anticlinal, whence it strikes generally, but with a northerly bend for Fishel's Brook, rising there in magnificent snow-white cliffs upwards of 100 feet high, and forming a well-marked ridge on either side of the river. On the southern side of the anticlinal the gypsum is not so largely or so clearly developed, but its presence is nevertheless frequently indicated by broken fragments scattered on the surface over the top of the conglomerates, and by brine springs, which seem to be a mineral characteristic of this part of the formation. Farther north, near Cairn Mountain, enormous masses of gypsum come abruptly against the great fault, or are overturned with the subordinate conglomerate in contact, showing a reserved dip. Still farther north, fragments of gypsum were observed along the lower reaches of Harry's Brook, where, from the apparently horizontal attitude of the subordinate strata, it was supposed that the division would occupy a tolerably wide area. At the mouth of Kippen's or Romain's Brook another great mass of gypsum forms a cliff, which was described in my Report for 1865, from which I quote the following paragraph:—

"On the north side of St. George's Bay, between the narrow isthmus of Port a-Port and Romain's Brook, thin flaggy beds of sandstone, some of a red and others of a greenish colour, come against a mass of limestone strata (Lower Silurian) by a fault. Between the exposure of these rocks and Romain's Brook a great accumulation of drift material, consisting of clay, gravel,

and sand, rises in bold banks over the shore, concealing the older rocks; but the sandstones again appear inside of Romain's Brook, associated with a great mass of gypsum. In this case the gypsum apparently protrudes through the sandstone beds, which are brushed up against its sides, and it forms a cliff of itself for some 8 or 9 chains, with a height in some parts of about 60 feet on the left bank of the stream."

Smaller masses of gypsum were observed inside of Port-a-Port Bay, but as these appear to occur at a higher horizon, and in the succeeding division (*c*), will be referred to farther on.

Although the great masses of gypsum appear to be mainly confined to the horizon here attributed to them, and although in some instances, as at Fishel's Brook, the mineral is continuous in large volume, running parallel generally with the rest of the formation for considerable distances, the conditions under which it occurs in relation to the associated rocks, differs in no essential degree from descriptions given of peculiarities attributed to the same substance in other countries. In every instance wherever a contact of the mineral mass was observed with the shales or limestones, the latter were found to be bent, broken or corrugated, or brushed up against the sides of the former, as if the gypsum had been injected or pushed through the associated rocks, in some cases, as at Codroy, enveloping and bearing along great broken fragments of the more solid strata. Whatever the true explanation of this phenomenon may be, one given in the 'Geology of Canada,' p. 352, 1863, seems in this instance to me to be the most applicable:—

"Certain appearances of disturbance in the gypseous rocks of the Alps have been explained by supposing that the sulphate of lime was at one time in the form of anhydrite, which by absorbing water was converted into gypsum with a large increase of volume, uplifting the strata around."

The succeeding division (*c*) is largely developed on both sides of Cape Anguille, on the north side of which it occupies the whole or the greater part of the coast between the Cape and Fishel's Brook, and is also exhibited in deep sections on the banks of the several streams. The most perfect and uninterrupted section was found on the banks of Fishel's Brook, which consisted of the following strata in descending order.

	Feet.	In.
1. Soft reddish and dark arenaceous shale holding nodules of sandstone, the colours alternating; the red in ribbon-like stripes	7	0
2. Variegated red and green arenaceous rocks, more coherent than the above	1	4
3. Bright red marls, yielding ochrous earth, and a substance like red chalk	26	0
4. Coarse browish-yellow sandstone, with narrow red stripes, and occasional rounded pebbles or concretions of sandstone	56	0
5. Thin-bedded red and green sandstone with red and green marly beds, mostly marl at the base	11	0
6. Variegated pale red and olive-green limestone, probably magnesian, in beds of from 8 inches to 2 feet thick; of fine texture, and probably capable of taking a high polish	10	0
7. Not well seen. Chiefly red and green sandstones and marls; conglomerate near the base	200	0
8. Grey, black-weathering, magnesian limestone; nodular or concretionary; bituminous, giving a fœtid odour when struck with the hammer	22	0
9. Red and green calcareous sandstones	15	0
10. Beds of grey magnesian limestone, varying from 2 to 10 inches thick, contains many fossil shells, one supposed to be a *Bellerophon*	20	0
11. Red and variegated marls, calcareous sandstones, and thin beds of limestone or dolomite	342	0
12. Blackish-grey magnesian limestone in beds from 3 to 14 inches thick, parted by divisions of blackish-blue shale. Fossil shells abundant, among which were recognised the following:—*Productus cora*, a *Naiadites*, a *Rhynchonella*, *Aviculopecten*, *Terebratula sacculus*, a *Naticopsis*, &c. ..	28	0
13. Red and green marls, not well seen	25	0
14. Alternations of brown sandstone, with brown and red arenaceous shale, which contain spots or bunches of carbonised and flattened plants. Some of the shales are striped with thin black carbonaceous layers	370	0
15. Brown, reddish-brown, blackish, and green marls or marly shales, with beds of brown and red sandstone; some of which are calcareous or dolomitic	740	0
Total thickness on Fishel's Brook above the gypsum ..	1873	4

On the sea-coast at Rattling Brook, southward of Fishel's, the stratum of magnesian limestone, No. 8, of the above section, crops out, and near it some masses of gypsum are seen along the shore, which seem to be nearly associated, the superior strata of sandstones and marls coming out at intervals farther north. These strata are again recognised on the coast north of Robinson's Head,

near the summit of a voluminous section, where the strike carries them towards the mouth of Red Brook on the north; but to the south near the bend of the bay, they are cut off by a north-west and south-east fault, with an upthrow on the western side, and they reappear near the outside part of Robinson's Head. A band of limestone or dolomite, representing No. 10 of the Fishel's section, crops out on the north side of Crabb's Brook, dipping N. 77° W. $<$ 54°, which contains, amongst other fossils, a *Bellerophon*? a *Rhynchonella*, and *Terebratula sacculus*; and on a hard silicious and calcareous rock below the limestone one or two surfaces were crowded with a multitude of small shells, supposed to be a species of *Naiadites*. On the west side of Crabb's Brook a series of red and variegated red and green marls, representing No. 7 of the section, come in dipping N. 64° W. $<$ 60°, which are overlaid by coarsish brown or brownish-red sandstones containing irregularly scattered pebbles of small size, and chiefly of quartz, in the upper beds, with some beds of a brick-red colour, and coarse red and green arenaceous shale. The thickness of the accumulation here above the limestone appears to be nearly 500 feet; the upper beds probably representing some higher strata than No. 1 of the Fishel's Brook section.

On the south of Cape Anguille a corresponding section is exhibited on the coast, between Codroy Island and the mouth of the Great Codroy River, a general description of which will be found in my Report for 1866, at page 87. The thickness in that Report is given as 682 feet, but the deficiency (if there really is any) may be accounted for by supposing the strata wanting to be concealed below the superficial material which covers up the whole country between Stormy Point and the Great Codroy River.

Limited sections of the division are exposed on the banks of the lower reaches of the Middle Barachois and Robinson's Brooks, the prevailing dip being northerly in both cases, but the strata are affected by folds which cause repetition; in the former, a little over a mile up its course, and within 3 miles on the course of the latter, below the outcrop of the gypseous band, division *b*. On the south side of the anticlinal, on the Middle Barachois, the measures display a prevailing south-easterly dip in disturbed strata, the angle from the horizon being usually high, and sometimes

vertical near the base of the section; and within a short distance of the gypsum a remarkable band of a very fœtid bituminous limestone crops out from among red and variegated marls and sandstones, which is crowded with fossils of a peculiar character. The forms in which these occur are extremely various, and it is doubtful whether they are to be considered of vegetable or animal origin, although there appears to be every reason to suppose that the bituminous character of the rock is due to their presence. The most usual form is imperfectly cylindrical, resembling an elongated cone, not unlike a *Belemnite*, truncated at the smaller end; but they are also often bent, and sometimes rounded, in which case they resemble the exterior form of a convoluted shell. I have been unable, however, on examination of a great many individual specimens, to detect any approach to internal structure in any one of them. This limestone was seen on the Middle Barachois on both sides of the anticlinal; on the north side, cropping out about 2 miles up its course, and on the south side about double that distance, where, coming against the Robinson's Head fault, it is thrown forward about a quarter of a mile on the east side, and reappears about that distance farther up the stream.

The division *c* of the formation is again exhibited in the lower reaches of Flat Bay Brook, and on the shores of Flat Bay, where a bituminous limestone, supposed to be the equivalent of the rock described above, crops out from amongst red and variegated shales. On the south-east side of the anticlinal in Flat Bay Brook region the rocks above the gypsum are entirely wanting, being cut off by the Great Fault.*

On the north side of St. George's Bay the members of division *c* are but indifferently displayed, their place in the coast section between Romain's Brook and Rivière Blanche being concealed by superficial deposits; but portions of it were readily recognised by the fossil contents, as well as by lithological character, in Port-a-Port Bay, where they are let down by a series of dislocations into juxtaposition with Lower Silurian strata. As these faults appear in some cases to have given rise to lodes holding the ores of lead in

* Patches of the Carboniferous series may possibly still remain among the mountains between Flat Bay Brook and Grand Pond, the latter being the nearest point where the formation is at present known to exist.

considerable quantity, and possibly other valuable minerals, they shall be more particularly alluded to hereafter.

The division *d* apparently succeeds the foregoing quite conformably, but is distinguished from it lithologically by the absence of calcareous strata, and the great predominance of arenaceous rocks, which constitute the greater part of the whole accumulation. The facts throughout seem to be in almost complete accordance with the section given by Mr. Richard Brown, of the Cape Breton coal-field, whose nomenclature would place the above divisions *b* and *c* as representative of the Carboniferous limestone; while division *d* would be on the horizon of the Millstone Grit, above which he places the coal measures proper, or the horizon where seams of that mineral are found to be productive. Whether the analogy of conditions continues in the upper strata of this province, still remains to be proved; but as there are evidences highly in favour of the probability, it is obviously of the utmost importance that the structure should be most closely investigated, and every effort made to arrive at certain conclusions as to the position and distribution of workable seams of coal. The seam long ago observed by Mr. Jukes, and which has often before been referred to by myself and others, crops out on the right bank of the Middle Barachois Brook, on a bearing from the entrance S. 65° E., 8 miles 55 chains; about 3 miles below which the lower rocks of division *d* cross the river with a south-easterly dip, upon which they gradually accumulate, advancing upwards in the order given below in an ascending section:—

	Feet.
1. Conglomerate, with brown and grey sandstone; the latter frequently holding scattered rounded pebbles chiefly of white quartz; very micaceous, the mica in rather small silvery or pale yellowish scales; dark bluish-grey micaceous sandstone more compact than the above; black carbonaceous shale at the top	320
2. Coarse grey micaceous sandstone in cliffs, with black carbonaceous shale, bundles of carbonised plants, calamites, and other vegetable remains. Much false bedding in the coarse sandstones; surfaces of some beds ripple-marked	30
3. Massive beds of dark grey micaceous sandstone with layers of conglomerate, pebbles small and rounded, rarely larger than a hazel nut. Stems and branches of *Sigillaria* and *Lepidodendron*, thin seams of coal one-eighth to one-quarter of an inch thick	180

	Feet.
4. Blue or purple-coloured clay beds, alternating with brown and grey micaceous sandstones; fine-grained greenish sandstones at the top, interstratified with slaty arenaceous shale. Much false bedding	462
5. Finely micaceous and arenaceous bluish-grey slate	132
6. Beds of fine-grained grey or greenish sandstone from 6 to 18 inches thick, alternating with blue or purple clays, and coarse flaggy arenaceous shale; stems of *Sigillaria* are very frequent in the sandstone, and thin beds present surfaces covered with carbonised remains of plants	363
7. Green and reddish purple-coloured, very micaceous sandstone, with thin beds of arenaceous shale	100
	1587*

The measures of the above accumulation were found in tolerably regular succession up to within about half a mile of the outcrop of the Jukes' seam, where they become disturbed, and are broken by a fault running N. 61° E., S. 61° W., on the southern side of which the strata are thrown into a vertical attitude. The strata on the north side consist of rotten soft brown and black carbonaceous shale, with a great quantity of coaly matter and obscure remains, some resembling *Stigmaria*, overlaid by coarse reddish sandstone; then more clunch and crushed carbonaceous material up to the dislocation. Above, or eastward of the fault, a set of red, flaggy, micaceous sandstones strike along the course of the river, N. 34° W., S. 34° E.

Over the red sandstone the section continues upwards as follows, on a dip N. 61° E. $<$ from 56° to 65°.

	Feet.	In.
1. Green, striped and spotted with red thin-bedded sandstones	90	0
2. Strong irregular beds of coarse brown sandstone with spherical concretions of sandstone; much false bedding; and beds of coarse arenaceous shale	40	0
3. A layer of soft brown argillaceous shale or clay with *Stigmaria*	0	6
4. Coal, 1 foot 3 inches; coal in thin layers alternating with thin layers of argillaceous and carbonaceous shale, 2 feet 3 inches. (Jukes' seam)		6

* The equivalents of this section, as exhibited between the Great and Little Codroy Rivers, was given in detail in an Appendix to my Report for 1868, when the thickness was estimated at nearly 3000 feet. It is not improbable, however, that it was somewhat overestimated, in consequence of repetitions of strata by a succession of parallel dislocations not clearly revealed.

	Feet.	In.
5. Black and brown argillaceous shale filled with remains of ferns, &c.	2	0
6. Alternations of reddish arenaceous shale and beds of red sandstone	30	0
7. Grey, reddish-weathering, finely laminated sandstone, dividing into layers from a quarter of an inch to 6 inches thick	30	0
8. Concealed, supposed to be red and grey arenaceous shale ..	20	0
9. Red, greenish, and grey arenaceous shale, and beds of grey sandstone	35	0
10. Green argillaceous shale with *Stigmaria*	2	0
11. Coal	1	5
12. Dark brown or grey argillaceous shale with ferns	1	0
Total	255	5

The beds which underlie the Jukes' coal seam strike across the river, bearing about south-east; but they gradually bend round and recross it, striking easterly, with a dip a little westward of north, at a pretty sharp angle. Farther up the stream the rocks of the same division present a variety of dips from north-west to north-east, usually at a very low angle, and occasionally for long stretches in perfectly horizontal strata, until getting a little over 3 miles above the position of the coal outcrops, where some red conglomerates and sandstones, with green shales, containing carbonised plants, come up, which were supposed to represent the horizon of No. 1, division *d*. Above this exposure the river becomes still, and the surrounding country flat for about a mile and a half, where no rock is exposed; but at the end of that distance the rocks reappear in a highly disturbed state, indicating the proximity of the Great Fault. The first rock observed at this part of the river section is a very dark brown or grey sandstone, which strikes across the river in a vertical attitude, bearing N. 19° W., S. 19° E., but some higher beds which succeed dip N. 71° E. $< 70°$. These are succeeded by some red and green sandstones, very much contorted, which form a sharp synclinal at an abrupt bend of the river, above which the rocks are again concealed. The brown sandstones come up again about a mile and a quarter above their first outcrop, dipping in the opposite direction; and a mile farther up fragments of gypsum were found on the banks and bed of the stream. The character of these rocks, together with the presence of gypsum, was supposed to indicate their horizon as belonging to

division *c*. A little beyond the gypsum, cliffs of contorted gneiss rise boldly from the banks, the river above cutting through a gorge of the Laurentian mountains.

The upper reaches of Robinson's Brook are generally unfavourable for obtaining a section of the formation in regular sequence, the bed of the river being thickly paved over by a great accumulation of boulders and rolled stones, while the banks are for the most part low, and composed of drift. After crossing over the basic conglomerate on the anticlinal axis, no rock is exposed for nearly a mile on the ascent of the stream; that is, about 6 miles in a direct line from the entrance, where some strata of fine conglomerate, with coarse red and green micaceous sandstones, cross the river, supposed to be about the horizon of No. 1, division *d*. Some small outcrops, usually of red or green sandstones, often vertical, are then seen occasionally in the bed of the river above; and at 9 miles in a straight line from the mouth a seam of coal, bearing on its strike S. 16° W., crosses the stream. A fortunate accident alone led to the discovery of this outcrop, as it was so completely enveloped in an accumulation of boulders, that it would certainly have been passed over unobserved, but for the removal of the loose stones, for the purpose of procuring a satisfactory dip upon some adjacent rocks whose bare edges alone cropped through. About a mile and a half below the place where the coal crops out, a set of coarse red sandstones, some beds of conglomerate, or sandstones with scattered pebbles, overlaid by thin-bedded or flaggy red and grey sandstones, whose surfaces were often thickly covered with carbonised remains, dip nearly due east, $< 30°$. A little higher up the stream the rock is a very soft red argillaceous and arenaceous shale, mottled and spotted with light green. These latter rocks seem to overlie the coal, and to lie in the centre of a synclinal fold, the seam coming out from under its eastern edge, which dips N. 75° W. $< 59°$. The place of the seam on the west side of the trough would accordingly be a little westward from the soft red east-dipping rocks mentioned above. Directly above the coal seam some thin beds of black carbonaceous shale were found to contain numerous fragmentary remains, amongst which some small and obscure forms were supposed to resemble scales of *Hylonomus*, as represented in Dawson's 'Acadian Geology.' The thickness of the coal seam, judging from the dip of the rocks on either side,

and the surface which was uncovered—viz. about 6 feet—appears to be about 4 feet. The mineral seemed to be homogeneous throughout, without any shaly divisions; it is very bituminous, burns with a clear flame like cannel coal, leaving a residue of white ash. The seam rests on an argillaceous rock with *Stigmaria*, but the roof was not distinctly seen. Ascending the stream above the coal crop we find a repetition of the strata seen on the west side of the synclinal, among the higher of which are beds of carbonaceous shale with *Stigmaria*.

The outcrop of coal upon Robinson's Brook bears from the uppermost outcrop seen on the Middle Barachois N. 30° E., distant 1 mile 70 chains; which being nearly on the strike of the rocks, it may fairly be assumed that the seam on the former is either the continuation of that on the latter, or else another very nearly on the same horizon.

The exposures higher up Robinson's Brook are still obscure, and for the most part they present a westerly dip, sometimes to the northward and at others to the southward of west, the angles from the horizon varying from 24° to 31°; but about 3¼ miles above the coal outcrop some strata are brought in, which so exactly resemble the soft red and spotted shales which overlie the seam, that they were supposed to be identical. Farther up the stream, moreover, near the end of our survey, some lower strata, resembling No. 1, *d*, come up with a north-westerly dip, $< 41°$. From these premises it was inferred as probable that a fold or fault on the western side of the soft red rocks, brought in the upper strata with the coal, which may form a second trough at no great distance from the Great Fault.

The lower members of *e* or upper of *d* were recognised on Fishel's Brook, between 7 and 8 miles up its course, where the dips indicate a synclinal form, but without bringing in the higher measures. This synclinal line corresponds in bearing with that seen upon Robinson's and the Middle Barachois Brooks, and is probably near its north-eastern extremity; in which case the coal seams, with the associated strata, will terminate before reaching Fishel's Brook, and will form the inner ellipse of a narrow elongated trough, lying about north-east and south-west, with the extreme points respectively at the Middle Barachois, and a little south-west from Fishel's Brook.

As the upper measures of division *e* of the section are nowhere exposed to view, we have as yet no correct data for the determination of its thickness; nor is it possible to define the bounds or width of the trough which contains it, as the country is at present circumstanced, without actual experiment by boring; still the evidences, so far as ascertained, tend to show that the central trough above described is not likely to prove over 2 miles across at its widest, and is most probably a good deal less; so, assuming that the average width is about 1 mile, and the average dip towards the centre about 30°, the total thickness would amount to 1320 feet. As the limits between *d* and *e*, however, are arbitrary—the separation being chiefly founded upon the presence of the most prominent coal seams—probably some of the upper strata of *d* might be included in the division.

In consideration of the analogy which has been shown to exist in the Newfoundland and Cape Breton coal-fields, a review of the equivalents, as given by Mr. Richard Brown, of the coal measures at Sydney, Cape Breton, may be of interest.

SECTION OF COAL MEASURES BETWEEN CRANBERRY HEAD AND STUBBERT'S POINT, SYDNEY HARBOUR, CAPE BRETON, BY RICHARD BROWN, ESQ., F.G.S., &c.:—

Descending Order.

	Ft.	In.		Strata Ft.	Strata In.	Coal Ft.	Coal In.
Strata				21	7		
Coal, Cranberry Head seam				..		3	8
Strata				15	8		
Coal	0	2					
Clay	0	2	Lower Cranberry Head seam	0	2	0	10
Coal	0	8					
Strata				245	8		
Coal	0	2					
Soft shale	0	8	.. ..	0	8	0	5
Coal	0	3					
Strata				17	3		
Coal	2	0					
Clay	0	2					
Coal	0	6	Lloyd's Cove seam	0	3	6	0
Clay	0	1					
Coal	3	6					
Strata				250	3		

	Ft.	In.		Strata Ft.	Strata In.	Coal Ft.	Coal In.
Coal	0	7	Chapel Point upper seam ..	0	5	0	11
Clay	0	5					
Coal	0	4					
Strata				106	11		
Coal	1	4	Chapel Point lower seam ..	2	9	2	1
Clay	0	4					
Coal	0	5					
Fireclay	2	5					
Coal	0	4					
Strata				21	6		
Coal				..		0	3
Strata				162	8		
Coal				..		0	4
Strata				178	9		
Above Sydney main seam				1024	6	14	6
Coal, Sydney main seam				..		6	0
Strata				43	1		
Coal				..		0	9
Strata				12	1		
Coal				..		0	4
Strata				130	11		
Coal	0	2	Quarry seam ..	0	3	0	8
Carbonaceous shale ..	0	1					
Coal	0	3					
Carbonaceous shale ..	0	2					
Coal	0	3					
Strata				76	9		
Coal				..		0	4
Strata				46	0		
Coal	0	5	.. ..	0	2	0	6
Carbonaceous shale ..	0	2					
Coal	0	1					
Strata				26	10		
Coal				..		1	3
Strata				120	4		
Coal	0	8	Indian Cove seam ..	0	1	4	8
Shale	0	1					
Coal	4	0					
Strata				61	9		
Coal				..		0	11
Strata				21	11		
Coal				..		1	4
Strata				20	10		
Coal				..		0	7
Strata				8	11		

	Ft.	In.		Strata. Ft.	Strata. In.	Coal. Ft.	Coal. In.
Coal				..		0	2
Strata				73	9		
Coal	0	1					
Shale	0	3					
Coal	0	2					
Shale	0	2					
Coal	0	2					
Fireclay	1	10					
Coal	1	2	Stony seam	2	10	3	0
Carbonaceous shale ..	0	2					
Clay	0	2					
Coal	1	3					
Carbonaceous shale ..	0	3					
Coal	0	2					
Strata				1	10		
Coal	0	2					
Shale	0	1					
Coal	0	1	Shelly seam	0	7	0	5
Carbonaceous shale ..	0	6					
Coal	0	2					
Strata				65	2		
Coal				..		1	0
Strata, with traces of coal in three places				72	5		
Strata below, and inclusive of Sydney main seam				786	6	21	11
Strata above				1024	6	14	6
Total strata and coal				1811	0	36	5

The above section accordingly shows favourably for the productiveness of the lower part of the division; the aggregate of coal being nearly 22 feet in the lower strata of 787 feet thickness, as against 14.6 in 1024.6 feet of the upper measures.

It will be observed by reference to the map that isolated and elongated troughs of division *e* are represented by dotted lines between Fishel's and Flat Bay Brooks; as also south-west of the Middle Barachois, towards the forks of the Great Codroy River. These representations are purely theoretical, and only intended to be somewhat of a guide to more minute examination hereafter, or to point out the positions where explorers in search of the mineral might apply the test of the boring rod with a reasonable prospect of success. The only indications of the presence of coal that I have seen in the Flat Bay Brook country were in some small fragments of the mineral mingled with the gravel, on the beds of the small

brooks which fall into the river on its left side; and as the banks of these brooks display no lengthened sections of the rock, and the interior between the streams is wholly enveloped in drift covered by forest or marsh, I see no means of arriving at a satisfactory conclusion in regard to productiveness, but by actual experiment.

Another important development of the divisions *d* and *e* occurs in the valley of the Rivière Blanche, where the section exhibited was estimated to reach about 550 feet in thickness; but there are grounds in support of the probability that the total amount of accumulation considerably exceeds that amount; which additional strata may possibly include seams of available coal. The lowest exposure of the rock is at a bend of the river about half a mile above the junction of the branch which joins from the north-east, or a mile due north from the sea-beach near the outlet. The strata there are coarse-grained micaceous sandstones, passing occasionally into conglomerates with many small rounded pebbles of white quartz, sometimes in layers, or scattered irregularly through the mass, alternating with beds of drab-coloured clay, and coarse micaceous and arenaceous shale. The attitude of these rocks is not far removed from horizontality; but the prevailing inclination by a series of observations appears to be nearly north-east, at an angle averaging from 7° to 9°. The strike consequently exactly coincides with the course of the river, which bears upwards north-west. The sandstones are everywhere crowded with carbonised and comminuted plants, and in the clays some forms resembling broken fragments of *Stigmaria* were seen. One surface of sandstone, about 2 miles above the junction of the north-east branch, is strewed over with trunks, limbs, and branches of Carboniferous trees; so that, as seen from a little distance, the appearance of the ground reminds one of a windfall or drift of modern wood upon a beach of sand. One trunk of a tree about a foot high, with a part of its roots attached, was observed to stand erect, or vertical to the plane of the bed; the rest were prostrate. An ancient log lay close by, 10 feet long by 2 in diameter, and near it lay a broken fragment with a bifurcation, 3 feet long and 15 inches thick. Another log partly imbedded measured 30 feet; while innumerable smaller limbs, branches, and stems were scattered over the surface or protruded through the beds. The

erect stump was cylindrical in shape; the prostrate logs and branches flattened. The interior structure was usually replaced by a sandy mud, sometimes enclosing woody fibre converted into coal; while the exterior was always of coal, where not exposed to atmospheric influences. The interior structure of some smaller remains of trees was found converted into a curiously radiated, crystalline, jet-black calcite, with bark of coal, and interstices filled with a black calcareous mud. Over this remarkable bed there is more sandstone and arenaceous shale, both showing much false bedding, intercalated into which is an imperfect bed of coal, irregularly underlaid by a thin layer of clay not over 1 inch thick. The thickest part of this mass of coal is from 14 to 15 inches, but it thins out entirely, wedging into the sandstone, at the distance of 15 paces in one direction; while in the other it can be seen for a few yards striking obliquely into the bed of the stream.

About 10 chains across the strike above this intercalation of coal, the banks of the stream expose some more sandstones dipping about north-east, $< 5^\circ$, at the end of which distance a seam of coal 6 inches thick crops out on the left side, underlaid by clay holding *Stigmaria,* and overlaid by a bluish shale, in which beautiful impressions of ferns and other vegetable remains were found in profusion. The highest exposures seen on the river are about 30 chains across the strike, higher up the stream, which at an angle of 5° would accumulate about 174 feet of superior strata; although the banks being chiefly of drift, the rocks are not clearly exhibited. *Sigillaria* and other plants occur in the highest beds seen. The banks of the stream above the termination of our survey, consist of stratified gravel and sand rising to the height of 50 or 60 feet; which accumulation is spread far and wide over the greater part of the area enclosed within the mountains, while the surface of the land, which is very level, is covered with dense forest. In such a country natural exposures of the older stratification need scarcely be expected; and there is no manner of arriving at a satisfactory conclusion in regard to the productiveness or otherwise of that strata, except by actual experiment. Should the dip last seen on the river be constant at an angle of 5° for a distance of 2 miles, there would be an additional accumulation of 870 feet; but, on the other hand, if the measures are turned up with an opposite dip, within that distance, or should

they become flat, it must be obvious that the accumulated thickness will be proportionally less, according to the circumstances.

Central or Grand Pond and Humber River Trough.

Although the region of the Grand Pond is beyond the limits of the season's survey, I consider a few remarks necessary in explanation of certain views regarding it, which have been suggested by a revision of the work of former years as compared with present experiences; and this is so much the more important, as a new light is now thrown upon the structure and distribution, by which I am enabled with more confidence to speculate upon the probabilities or possibilities which may attend further and more minute investigation, especially in regard to economic results.

Upon carefully comparing the fossil contents and stratigraphical character of the rocks of the interior with those of the coast and river sections of St. George's Bay, it would appear that in the former the lower members *a* and *b* are nearly or entirely absent; while the middle or upper part of *c* constitutes, on the Grand Pond, the base of the series. The succeeding division *d* is largely displayed upon the Grand Pond, and a part of division *e* is recognised at the north-east end of the lake by the presence of fossil trees, and seams of coal. The measures are on the whole moderately flat, except near the junction with the Laurentian rocks, where they are often turned up at a high angle by dislocations. On the Grand Pond the lower measures strike across the lake at the northern end of the great island, the sandstones of *d* succeeding upon both shores, which on the south-east side butt obliquely against a mass of trap, running in a north-east and south-west fault. On Deer Pond a conglomerate was seen at the base of the formation, which in 1866 was supposed to be on the horizon of *a* division, but the character of the associated rocks, the fossil contents of the sandstones, and the apparently total absence of any representation of the gypseous division, seem to place it as more nearly equivalent to the upper part of *c*. The sandstones of *d* are displayed extensively in the valley of the Humber River, but being nearly quite flat, except where disturbed by dislocation, the thickness is not easily ascertainable; and it is doubtful whether or not the upper strata of *e* are brought in at all.

In my Report 1865, p. 64, the presence of small seams of coal is mentioned, as having been noticed in the valley of Coal Brook near the north-east angle of the Grand Pond; and at the end of the same paragraph it is remarked, "That if workable seams of coal exist in the central trough, the country where such may be expected to be found will be in the region between the Humber and Sandy Pond, where there is ample room to bring in a large accumulation of strata, &c." I am still of opinion that the region there referred to is situated more favourably than any other in this respect; although the recent discovery of a seam 17 inches in thickness on the Coal Brook, leads me to suppose it by no means improbable that larger and more productive seams may be discovered, by trial with the boring rod, near the banks of the Main Brook, or near the northern shores of the Grand Pond.

Faults.

It may be observed, from what has been stated in the preceding pages, that great disturbances must have taken place since the coal period, to bring the different members of the formation into the contact displayed along the lines of junction with the Laurentian and Lower Silurian rocks, to have occasioned their frequent vertical attitude; and to have brought beds of the same series, remotely apart in stratigraphical order, into juxtaposition. It is remarkable also, that notwithstanding these disturbances, no direct evidence of volcanic or igneous action has hitherto been perceived in any part of the region; the trap which occurs on the Grand Pond, and against which the Carboniferous rocks abutt, being apparently of older date, although in all probability indirectly the cause of the dislocation.

The prevailing direction of these dislocations is more or less nearly north-east and south-west, corresponding with the general parallelism of the great geographical features, to which in many cases they may have given origin. There are, however, many faults which run obliquely or at right angles to this course, and some curious effects of the intersection were observed at one place, which shall be described presently.

In my Report for 1866 a great fault is represented as intersecting the country from near Cape Ray to White Bay; more

evidences of which were afforded again this season by the attitude and abrupt termination of the several members of the Carboniferous group at the upper parts of the rivers surveyed, and near the foot of the mountains. There seems also to be good ground for suspecting that a bifurcation of this fault takes place near the mountain gorge of the Middle Barachois, which probably communicates with the trap and fault on the south-east side of the Grand Pond, and finally follows the depression of the Indian Brook towards Hall's Bay; maintaining almost a straight course for the whole distance. From the place of the supposed bifurcation the more northerly fault runs across by the still water reaches of the river, at the foot of the mountains, keeping a straight course up to the expansion of Flat Bay Brook, at the Cairn Mountain, and a few miles beyond, where the last great mass of gypsum was seen in contact with the Laurentian hills; a little north of which, near the Little Barachois, a second bifurcation appears to take place, the most westerly fault running on the eastern side of the valley of Harry's Brook, being observable in the Silurian strata around Es-que-dege-weh Gospen, at the head of the eastern branch, bearing thence towards the lower reach of the Humber River. The eastern branch of the fault is the one alluded to in the Report of 1866, as striking upon the south-east side of Deer Pond, and thence up the valley of the Humber River to White Bay.

The east and west bays of Port-a-Port are separated by a long low peninsula called Shoal Point, which is represented on the map as being supported by a portion of division *c*. The shore of the East Bay between the neck of the peninsula and the Gravels, is indented with a succession of coves, each of which affords remarkable examples of those intersecting dislocations by which the Carboniferous rocks have been let down amongst strata of Lower Silurian age; and which are perhaps worthy of especial notice, in an economic point of view, from the circumstance of their containing deposits of metallic ores, which may prove of great value.

On the shores of St. George's Bay, about a mile and a half from the eastern outer point of the Gravels, a fault was observed where some red or brownish sandstones of the lower Carboniferous formation are brought into abrupt contact with a set of hard whitish mottled with red sandstones, supposed to be of Potsdam

age. Bearing on a course N. 85° W., this fault runs obliquely across the pond at the Gravels, entering on the west side in a depression between exposures of limestone beds, which contain many fossils distinctly typical of Calciferous age. The effects of this dislocation are then seen at the heads of the successive coves westward of Shag Point, where the Carboniferous limestones, with red marls, sandstones, and shales are let down in confused and broken strata, amongst the beds of Lower Silurian, which latter hold the outer coast line, dipping with a regular and gentle slope northerly towards the bay. From the cove, now known as Lead Cove, about half a mile west from Shag Point, the fault bears a little southward of west, its effects being similarly shown at each of the succeeding indentations, and finally coming out on the coast at the bend of the bay, on the east side of the Shoal Point peninsula, where the newer formation is exposed at intervals, striking along the shore.* At each of the aforesaid coves the effects of further dislocation are plainly manifested in the cliffs of both Silurian and Carboniferous rocks, where the faults which are frequent, and all rudely parallel, run nearly due north and south, or at right angles to the break just described.

The relative age of the two sets of dislocations is difficult to determine, but the impression left by a careful examination of several coves was that the north and south running faults were the older, while the great east and west fault was the means of producing the confusion and anomalous position in which, in some instances, the more recent formation appears to underlie the more ancient. The Calciferous rocks are cavernous, in many cases being worn out by the action of the sea for considerable distances, and some beds have a tendency to wear into peculiar forms, sometimes assuming a grotesque resemblance to a colossal human figure. The process of disintegration which has produced and is still producing these effects seems to be to wear the edges of the fissures and dislocations by which the rock has been previously intersected, first into concave surfaces resulting in pillar-like masses, which subsequent action has modified into all manner of shapes. A pillar-like bed may be seen, with concave sides, overlaid by one

* The western extension of this fault is supposed to run for the head of the west bay, and probably thence across the peninsula; but all that part requires more investigation.

worn round with a convex edge like a huge cheese. At other times several beds are piled over one another, all with convex edges; others are worn concave on the lower surfaces, and these again piled up like inverted plates; while others take a pyramidal or conical form resembling a nest of weights. In short, there is no end to the fantastic forms produced, all of which are being gradually undermined, and will eventually disappear, to be succeeded by a newer set, carved out by the same process. One cavern among these rocks is with some difficulty accessible from its exit on the shore, bearing in a westerly direction for 120 feet; another is wide and open, and can be followed at low water for about 30 yards; while many more, in an incipient state, may be seen wherever the same beds are exposed.* We can readily suppose rocks having these tendencies to have been hollowed out in remote times into vast subterranean caverns by the erosion of running water, or by the action of the sea working through fissures and cracks, thereby undermining the unconformable Carboniferous, and then horizontal strata, in which case the superincumbent mass, thus unsupported when affected by a slight dislocation, would inevitably be precipitated in a confused and broken state into the abyss below, producing the anomalous attitude in which we now find the newer and older formations to come together. That much of the disturbance here is local seems evident, seeing that while the Carboniferous rocks are broken, twisted, and corrugated, the underlying Lower Silurian beds, on both the north and south sides of the fault, are but very slightly affected by the movement, and dip at a very gentle angle and with perfect regularity to the northward. Moreover, judging from the amount of Carboniferous strata as exposed in the cove sections, and the position the supporting rocks display, the collapse probably did not occasion over 100 feet, at most, in vertical fall together.†

The interstices and fissures occasioned by these cracks and dislocations are usually filled or lined with calc spar, generally in

* Some of these caverns in Silurian limestone are thickly encrusted with a calcareous mud, which contains many characteristic Carboniferous marine fossils; from which circumstance it may be inferred that they were worn out previous to or contemporaneously with the older Carboniferous time; and that the fossils have been washed into their present position by the waves of a Carboniferous sea.

† See Figures 1, 2, and 3, 4.

large coarse crystals frequently of scalenohedral form, with which galena is abundantly disseminated; while huge masses and balls

FIG. 1.

Before dislocation.

FIG. 2.

After dislocation.

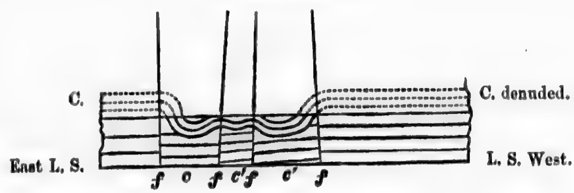


FIG. 3.

Before dislocation.

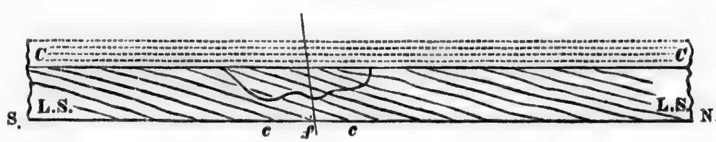
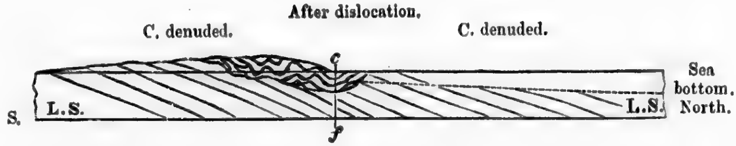


FIG. 4.

After dislocation.



C. Carboniferous; L. S. Lower Silurian; *c*, Caverns worn in L. S.; *c'*, Caverns filled with C.; *f*, Faults.

or nodules of iron pyrites, probably mispickel, were found imbedded in limestones, clearly characterised by the presence of many typical Carboniferous fossils, such as *Terebratula sacculus*, *Rhynchonella*, *Conularia planicostata*, and many others. Although the ores of lead appear to be disseminated more abundantly in the fractures of the Carboniferous than in the adjacent and underlying Lower Silurian strata, it appears, nevertheless, highly probable that the latter is the source from whence they have been derived. Dislocations and cracks, many probably Pre-Carboniferous, occur along the south coast of the peninsula, where the ore may be seen running in strings of prill, or in segregated cubical or octahedral crystals, while isolated crystals and irregular and thin strings may often be detected, scattered through or between the beds of limestone.

Laurentian and Lower Silurian Formations.

Without entering into a detailed account of these rocks—a subject which, as stated at the commencement of this Report, is reserved for a future occasion—a slight sketch of their general distribution may be looked for, as forming the base upon which the important formation we have been discussing is deposited.

The presence of labradorite and other anorthosites in the gneissic rocks of the Indian Head range, the hills of the Little Barachois, and the Cairn Mountain, gives rise to the supposition that they belong to the upper or newer Laurentian series, as which they are represented on the small scale general map; while the angular boulders and fragments of white crystalline limestone with graphite, on the upper waters of the Great Codroy River, was suggestive of the proximity of the upper members of the lower series. The rocks which were seen in the interval between these extremes, where the rivers leave the mountains, were of gneiss, with much hornblendic and micaceous schist, and probably belong to the lower division.

There is reason to suppose that members of the Lower Silurian system are overlapped by the Carboniferous formation in the same

region, and that possibly some remaining outcrops of that age may still exist upon the flanks of the Long Range mountains. The presence of numerous boulders and fragments of Calciferous limestone in the Lower Carboniferous conglomerate is indicative of the first case; while in the second the evidences are in the superficial boulders of the same rocks, mingled with others of Laurentian gneiss, which are found upon the banks and beds of the streams.

Strata of Lower Silurian age are largely developed on the Port-a-Port peninsula, both on the outer coast and within the inner bays, the extension of which on the strike form the outer hill ranges of the mainland, and they occupy the greater part of the 2nd and 3rd areas. The lowest rocks are a set of whitish-grey mottled with red, magnesian limestone, which skirt the northern shores of St. George's Bay from the Gravels westward, with some interruptions of higher strata. These have been supposed to represent the upper part of the Potsdam formation, or about the horizon of B or D, page 865, chap. xxii. of the 'Geology of Canada.' Further research, and especially the discovery of fossils, may prove these beds to be of younger date, possibly to be brought within the Calciferous or the base of the Quebec group. Of the rocks succeeding them, mention is made in my Report for 1865, some fossils from which were referred to Mr. Billings for examination, whose memorandum on that occasion I now quote:—"This rock is the upper part of the true Calciferous, and lies next below the Levis formation. They belong to the divisions H, I, K, L, M, page 879, 'Geology of Canada.'" A good section of these rocks is exposed on the western side of the Gravels and of the Pond within, where the strata succeed each other with great regularity, intercepted only by the east and west fault (where they are concealed) from the western outer head to Shag Point, dipping nearly due north, $< 17°$; giving a thickness altogether of 1594 feet, from which 20 or 30 feet may be deducted for repetition by the dislocation. The upper beds of this section are those which weather and wear into the peculiar forms and caverns already described, and which contain characteristic fossils in abundance. These rocks strike obliquely into the land north of the Gravels, and at a cove about a mile and a quarter from the north-east

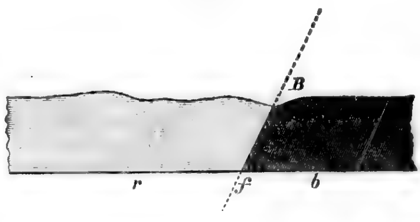
corner of the pond they are overlaid by the following section, the dip at the base being N. 15° W. < 22°, section in ascending order:—

	Feet.
1. Grey bituminous limestone, with partings of black or grey shale	4
2. Thin beds of limestone, alternating with black or dark grey shale, mostly shale at the top, in which many fossils occur; *Lingula*, *Obolella*, some *Trilobites*; simple and compound *Graptolites*	6
3. Dark blue earthy bands of limestone, from 3 to 6 inches thick, with black or dark grey shales, alternating in about equal proportion. Upper part filled with fossils, chiefly graptolites.	23
4. Black shales with numerous fossils, graptolites	40
5. Dark grey calcareous sandstone in beds from 6 inches to a foot thick	20
6. Limestone conglomerate	30
	123

The fossils and mineral characteristics of these rocks, together with their stratigraphical place in relation to the Calciferous, leave little doubt that they represent a part of the Levis formation, and equivalent to N, O, or P, page 865, 'Geology of Canada.'

Proceeding northerly along the coast, the above section is succeeded by more black shales, which begin to show the effects of disturbance, and are finally brought into abrupt contact with a set of red shales by a fault (see Fig. 5).

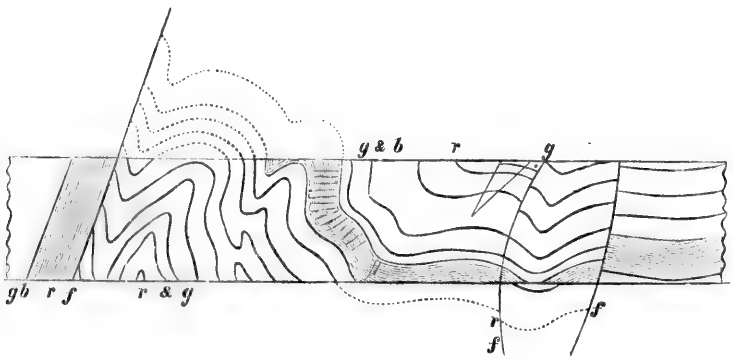
Fig. 5.



Farther on, the cliffs exhibit red and green shales in very contorted and dislocated strata, as shown in Fig. 6.

This corrugated section is then succeeded by black and greenish shales with red shales at the base, which are again overlaid by

Fig. 6.



b, Black Shales; *g*, Green Shales; *r*, Red Shales; *f*, Faults; *B*, Brook.

strata showing a dip N. 14° W. < 55°, as follows in the ascending order:—

		Feet.
1.	Green and red shales alternating	10
2.	Blackish and dark green shales; small fault at the end	15
3.	Thin-bedded limestone, beds from 2 to 6 inches thick, parted by dark green shale, steatite in cracks	6
4.	Green shale	10
5.	Red shale up to a fault	20
6.	Green shales with thin bands of coarse sandstone, slightly micaceous and spotted by green carbonate of copper	18
7.	Green shales with occasional bands of red	20
8.	Dark greenish shales with thin beds of limestone, and limestone conglomerates at the top, in beds from 6 inches to a foot thick	16
		115

The pebbles of the last (No. 8) appear chiefly to be derived from the Calciferous rocks, but there are also pebbles of trap, black chert, and a few of syenite or gneiss.

The rocks are concealed then for some distance, and the next exposures consist of black, green, and red shales, with thin beds of grey limestone, of which the total thickness was estimated to be about 130 feet; then follows a set of corrugated broken-up green shales, of which it was impossible to ascertain the thickness, over 350 feet of distance, where they came abruptly against a fault

running N. 21° E., which separates them from a mass of sandstone and conglomerate. The sandstones of this section are of a greenish-grey colour, in beds from 6 inches to 1 foot thick, having conglomerate beds interstratified of 1 foot to 18 inches in thickness, which prevail towards the top. The total thickness exposed here amounts to 274 feet, beyond which there is a long stretch of sand-beach, where the rocks are concealed. The outer point beyond, about 3 miles north-east from the Gravels, exposes cliffs of coarse grey or greenish-grey sandstone with conglomerate beds, which are also frequently barred or striped with irregular bands of dark grey nodular limestone. The conglomerates contain pebbles of limestone, and occasional beds have many fragments of black shale or slate; the matrix appears to be chiefly of particles of feldspathic and quartzose sand, probably derived from Laurentian rocks; and many of the pebbles are coated with green carbonate of copper. Drusy cavities in the rocks are lined with crystals of calc spar. At the end of the section the sandstones are quite vertical, but a little way beyond more red shales come in dipping N. 14° W. $<$ 54°, upon which they, with alternating green shales, accumulate 500 feet in thickness. Red, black, and green shales are then exposed in very contorted strata for 248 paces nearly across the strike, up to an exposure of corrugated thin beds of limestone, interstratified with jet-black shale or slate, with which there are occasional bands, 2 or 3 inches in thickness, of solid iron pyrites. These last measures continue to be obscurely exposed for about a mile to the bend of the shore about 4 miles from the Gravels, beyond which there are no exposures on the coast till passing Fox Island Brook.

An amorphous mass of rock runs for about a mile northerly from Fox Island Brook, forming a low cliff along the shore. Portions of this rock are brecciated or concretionary, but it is also irregularly striped with red and green jaspery bands, and patched with a red and white limestone or dolomite, and some black earthy trap-looking slightly calcareous rock, probably a diorite. The whole of this mass seems to be more or less calcareous, and the interstices of the innumerable cracks and fissures are invariably filled with calc or bitter spar. These reticulating veins are often tinged with green carbonate of copper, and thin films of metallic copper are frequently found lining the fissures, which

probably give rise to the stains. Towards the end of the exposure a hard, brittle substance, resembling jet, reticulates through the rocks in a blackish-grey calcareous or magnesian earthy rock. It is crystalline with a conchoidal fracture, shining black in colour, and very pulverulent. Small strings and patches of calc or bitter spar are combined with these reticulations.

About a mile of sand-beach succeeds the aforesaid cliffs, in which no rock is seen; but towards the bend of the coast approaching Bluff Head, red and green shales are again exhibited, which show a dip N. 76° E. $<$ 72°, of which about 50 feet of thickness is displayed in the cliff; and in section across the measures at low water 350 feet more, or about 400 feet in all. The shales are then succeeded by massive beds of conglomerate, with calcareous pebbles, overlaid by a great accumulation of sandstone, with some red and green shales interstratified, which crop out at intervals along the coast. The sandstones are folded over at one place, and can be seen at low water dipping in opposite directions; they are obviously dislocated several times by small faults, and are otherwise more or less irregular; but as in the northerly part of the section the slope is pretty uniformly towards north-east, with an average inclination from the horizon of not less than 45°, there is room to bring in a thickness of upwards of 1800 feet. Beyond the little brook which falls about half a mile south-west of Bluff Head, some thin beds of limestone run out at intervals, and one great bed of limestone conglomerate, north of which a mass of trap breccia intervenes between it, and an accumulation of arenaceous shale, succeeded by more sandstones. The breccia, which extends to and is more largely displayed on Fox Island, consists of an enormous aggregate of angular fragments of syenite, black chert, red jasper, trap, and slate, cemented together by a bottle-green silicious paste, which is sometimes slightly calcareous. The whole of the south shore of Fox Island is of this rock, but the northern parts appear to be chiefly or altogether of greenstone. On the main shore, immediately north from the breccia, are the arenaceous shales, which are very micaceous, dividing into fine soft laminæ not thicker than brown paper. Over these are a series of pale grey yellow-weathering sandstones, in beds of from 1 foot to 18 inches in thickness, succeeded by fine conglomerates and more sandstones in very massive beds, sometimes 10 or 12 feet

thick, between the divisional planes. The exposed surfaces of some of these beds are curiously honeycombed by little cells about an inch in diameter. These sandstones were supposed to be a repetition of those last seen farther south; they come close up to the foot of Bluff Head, which is of serpentine, but the manner of junction is very obscure, and there is evidently a fault running south-east between them and the mountains.

The serpentines of Bluff Head are for the most part of a blackish or dark bottle-green colour, and with them are associated greenish diorites, chloritic slate, and masses of a brownish-red coloured limestone which is intersected and spotted by pure white calc spar, associated with green chlorite. A rude and corrugated semblance of stratification is observable at some parts of the Bluff Head section; the purer serpentine being at the base overlaid by a thick stratum of soft chloritic rock, above which is a thick mass of impure serpentine with a slaty structure to the top of the cliff. Seams of asbestos are frequent in the serpentines, usually not over one-eighth of an inch thick, but larger veins occur occasionally, some of which may prove of economic importance. Portions of the serpentine weather of a deep Prussian-blue colour, other portions are of a rusty red, while a pale yellowish-green obtains where the rock assumes the structure of picrolite. Stains of the green and blue carbonates of copper were seen among the rocks at some parts, and at one place on the north side of the head some cubical crystals were found in a small fissure, which were supposed to be arseniate of nickel.

As our survey of this part of the coast terminated at Bluff Head, nothing certain can be said of the succession farther north; but from information received, there would appear to be another great development of sandstone before reaching the outlet of Coal River. Whether this sandstone is a repetition of the rocks seen south of Bluff Head, or higher strata, can only be proved by further and closer examination.

From what I could learn from those who had visited the Western Bay, which I was unable to do, the graptolitic shales representing the Levis division strike into the land on the west side of that bay, and can be followed in a south-westerly direction for a considerable distance up a small brook which falls in there; but the middle point of the bay is said to be of limestone where

no fossils were found, north of which more shales are displayed, characterised by containing many nodules and balls of iron pyrites. The shores of the Long Point peninsula facing the bay are bounded by cliffs of limestone from 50 to 60 feet high, which show a dip with considerable regularity N. 39° W. < 22°. These limestones are very fossiliferous, and among the fossils were recognised one or two species of *Leptæna* or *Strophomena*, many encrinites, and a vast quantity of spherical-shaped masses, supposed to be corals.* Externally these present a set of concentric rings on the upper surfaces; internally, they show a finely radiating structure from centre to circumference.

The supposed probable structure of the 3rd area is shown upon the map from such few facts as were ascertained. They indicate a series of great synclinal and anticlinal folds, bringing the upper part of the Levis rocks, represented in the Long Point cliffs, as the uppermost part of the Lower Silurian group in a westerly direction; but as the limits of our time permitted only of a very superficial examination of this area, there is still much obscurity in the stratigraphical arrangement, which nothing short of a thorough investigation can clear up.

Economic Substances of the Region.

Coal.

Of all mineral substances, coal is perhaps the most essentially valuable and important to any country that is favoured by its presence in workable abundance; and no effort should be spared to develop the productiveness of any region where the evidences point towards its existence. It will be perceived by what has been said in the description given of the distribution of the coal series, and better still by reference to the map, that the natural outcrops of coal seams are few; and, moreover, that the areas occupied by what may be termed the productive measures, are very limited in extent. In regard to natural outcrops, it is not surprising that they should rarely come into view, seeing that, except in the courses of the rivers, the whole region is wrapped up in a thick mantle of superficial drift, which is itself grown over

* *Titradium* ?

by a dense forest, or covered by vast bog or marsh. And even in the river sections, as I have already shown to be the case in Robinson's Brook, the rocks are often so thickly covered over with boulders and other débris, as to be all but totally concealed for miles together. Nevertheless, the few outcropping edges that have been seen are of themselves sufficiently important to justify a careful experimental examination being made, to ascertain the thickness of such seams at the different parts of their distribution; or possibly to strike upon others as yet quite unknown. For this purpose the boring rod ought to be diligently applied; and while the evidences so far tend to show that the areas represented on the map by *e* are those in which workable seams are most likely to be found, it must not be supposed that the experiment should be limited to those spots alone. On the contrary, it would be well if a systematic plan of boring were adopted in sectional lines from the shores of St. George's Bay to the mountains in each Carboniferous area; as, although in many, or most parts, the presence of workable coal would be highly improbable, there are other mineral substances, salt for example, which in springs or in solid form might be struck, especially among the lower rocks of the formation, and which may exist also more or less among the higher measures. That the process of boring, which I recommend, ought to precede any direct attempt to open up mines, must be obvious for many reasons; one of which is that the result of a series of experiments would indicate the most eligible positions for sinking shafts, and likewise the directions in which the underground work should proceed with most advantage. Another matter would be proved also of much consequence in regard to the actual thickness of individual seams, respectively at one place and at another; for it is a fact well known to practical colliers, that one and the same seam will be found in many cases to vary essentially in productiveness, even within short distances; and that a *splitting* or *wedging out* will occasionally happen which will reduce the thickness of the fuel from many feet to a few inches. Nevertheless there often appears to be a persistence in coal seams over the sedimentary strata with which they are associated—a phenomenon well exemplified by Mr. Richard Brown in his work upon the Sydney coal-field. Comparing the column of strata as found at Lingan, on the one hand, and at Low Point on the other,

Mr. Brown says, "From No. 1 to No. 5 (in the two sections) the agreement is perfect, although the thickness in the intervening strata in the Low Point is nearly *four times greater* than in the Lingan section." Again, he says, a little farther on regarding the coincidence of the two sections, "The exception just mentioned occurs in the Lingan seam No. 5, consisting of two beds of 3 feet, and 5 feet 8 inches of coal, separated by only *one inch of shale* at Indian Bay, which is represented by the 3-feet and the McGillivray 5-feet seams, *separated by* 138 *feet of shale,* upon the Low Point shore." Further, he says, "Having an instance of an increase of *twenty-eight feet in half a mile* before us, it is not unreasonable to assume that the same bed of shale has increased to 138 *feet in a distance of seven miles.*" To these remarks a footnote is added which is worthy of quotation, as showing the necessity of experiment, particularly in an unknown and totally wild country:—"One of the most remarkable instances of *the splitting of a coal seam* occurs in the northern part of the South Staffordshire coal-field, where the several beds of the thick coal, or 10-yard seam, have been *split into nine distinct seams;* the highest and lowest being separated by 240 *feet of sandstones and shales,* within a distance of five miles."

Another example may be quoted of similar occurrence upon this side of the Atlantic, and upon what may be considered the same great coal-fields as that of which the Newfoundland series forms a part:—"The coal measures of the Albion mines, Pictou, consist of the same materials, and contain many of the fossil remains with those of the Joggins, but they differ in the arrangement of these materials and fossils. Instead of a great number of thin beds of coal and bituminous shale, we have here a few beds of enormous thickness, as if the coat-forming processes, so often interrupted at the Joggins, had been allowed to go on for very long periods without interference." *

With respect to the contracted size of the productive areas, it has been shown in preceding pages that on the south side of St. George's Bay the dips are usually high, and that consequently a great accumulation of strata will occupy but a short distance across the measures, with which measures seams of coal in all probability are interstratified; while on the north side of the

* See Dawson's 'Acadian Geology,' p. 318.

bay, where the dips are at a low angle, there is ample room within the Carboniferous ground to bring in a thickness of upwards of 1000 feet.

Coal is reported to exist in the valley of the Coal River, and a seam of nearly a yard thick is said to have been seen about 14 miles up the stream. As our survey did not extend to this part, no particulars can be given; but judging from what could be seen of that valley from the tops of the mountains of the water-shed, I conceive there can be very little room for a large accumulation of coal strata, and that workable seams are likely to be of very limited extent.

Salt.

From the frequent occurrence of brine springs throughout the Carboniferous regions, and especially near the gypseous division (*b*), there is every reason to believe that salt may be manufactured to a large extent, and become an article of commerce. Moreover, it seems by no means unreasonable to suppose, from various circumstances that have been observed, that the mineral may still exist in the solid form at some parts, which the use of the boring rod may eventually prove. On the Middle Barachois Brook, about 5 miles up its course, the water running from the left bank for nearly a mile, is so strongly impregnated with salt as to be quite unpotable, while the rocks near by were encrusted with fine crystals of the mineral. Salt was also seen on the upper reaches of the same river encrusting the strata. The basic conglomerate strata on Robinson's Brook is likewise so encrusted; and on the north side of the anticlinal, near the left bank close by an exposure of the gypsum, in a deep conical depression, with a strong spring bubbling up in the centre, the water was found to be slightly brackish, being there diluted by the waters of the stream. It has also been stated, when describing the distribution, that saline water was found to proceed from the small faults in the basic conglomerate at Fishel's Brook, and that at the southern termination of division *a*, on the same stream, a strong saline spring bubbles through the soil. Between Flat Bay Brook and the hills near Cairn Mountain, a set of great cavities, resembling inverted cones, were observed in 1866, and spoken of in the Report for that year. These are situated very near to the

position of the great mass of gypsum, and supposed to have at one time been reservoirs of crystalline salt, long since dissolved. Similar depressions occur also close by the gypsum at Romain's Brook.

In the east Bay of Port-a-Port, about a mile west from Lead Cove, a mineral spring issues from a fault in the strata, which is supposed to possess medicinal qualities of a high order; and is resorted to by the nearer inhabitants as a specific for many diseases. A sample was taken for analysis, but as yet I have had no opportunity of having it submitted to that test. Within half a mile from the spring, some small masses of gypsum protrude through the beach.

Several similar springs were met with in the valleys of the Brooks of the 1st area.

Gypsum.

This mineral is perhaps distributed more profusely and in greater volume in the Carboniferous country of the 1st area than in any part of the North American continent of the same extent. The enormous development of it at Codroy, the Highlands, Middle Barachois, Robinson's Brook, Fishel's and Flat Bay Brooks, are evidences of the persistency with which it preserves its place in the stratigraphical sequence; while the more isolated masses of Harry's Brook, Romain's Brook, and Port-a-Port Bays, are instances of its presence on the northern side of St. George's Bay. As an article of export, the great objection which presents itself is the absence of secure harbours; Codroy and Sandy Point being, as already shown, the only safe places to embark cargo; but its value for agricultural purposes, were the St. George's Bay regions settled, cannot be overestimated. In order to show the value and importance of gypsum, as also the various purposes to which it is applied, I quote the following from the 'Geology of Canada,' chap. xxi. p. 763:—

"The amount of gypsum raised from the various quarries on the Grand River is about 14,000 tons, which is for the most part employed for agricultural purposes, and is consumed in Western Canada. The price of the crude gypsum at the mine is about \$2 per ton; but when ground for use at the mills in the vicinity, it is sold at from \$3·50 to \$4. Much of the gypsum is white and

pure, and is well fitted for the purposes of cement and stucco. The quality which is used for this purpose sells, when ground, at from $5·50 to $7 per ton; and when calcined, at $16 per ton. Large quantities of gypsum are brought to the Lower Canada market from the Magdalene Islands."

These particulars apply as far back as the year 1863; probably the consumption at the present time is much greater, and the price higher. All the varieties spoken of, are to be had in abundance in the gypsiferous deposits of Newfoundland.

Lead.

The ores of lead were frequently met with in the cracks and crevices of the Silurian rocks of Port-a-Port, or 3rd area; but the largest surface development that was seen was among the crushed and shattered Carboniferous strata, where they were let down by dislocation, as has already been stated, when treating on faults. The opening which was commenced at Lead Cove, on the property of the Hon. C. F. Bennett, was, at the time of my visit (July 1873) entirely among the dislocated Carboniferous rocks where the greatest display of galena was at the intersection of the east and west, with the north and south faults. A shaft was then being sunk, and an adit driven near one of these intersections, but neither was sufficiently far advanced to prove the mine, or to determine with certainty the direction the principal ore-bearing part of the lode would tend. The impression left on my mind was, and still is, that the most productive, and certainly the easiest worked part, will be found to be among the more superficial Carboniferous rocks, although the ore may prove to be more solid and compact in the dislocations of the inferior strata.

Magnetic Iron Ore.

In my Report for 1866, at page 94, a notice is given of the presence of magnetic iron ore at the Cairn Mountain, near Flat Bay Brook. Hitherto I am unaware of this ore having been struck in any great mountain mass, although, from the persistency of its appearance on the surface in angular fragments, and in the form of magnetic iron sand, together with its frequent presence

IMAGE EVALUATION
TEST TARGET (MT-3)

6"

in the basic Carboniferous conglomerate division (*a*) in rounded boulders, I have much confidence of its existence, as such, along the range of the Laurentian hills.

Various Useful Substances.

The other economic substances of the region are building stone, limestone, grindstones, whetstones, red and yellow ochre, petroleum, peat, and shell marl.

The sandstones of the coal measures are often of an admirable quality for building purposes, and usually easily worked; while others are probably well adapted for grindstones and whetstones. Excellent examples of the latter description were observed on the Grand Pond. The limestones of the same system are occasionally fit for burning into lime; but in many instances they appear to be magnesian, and consequently may not be well suited for application to the soil. The Silurian limestones on the north side of the bay, although not invariably, are generally capable of being used for all the purposes for which that rock is required. Particulars regarding these and other mineral substances, will be found in my Report for 1866, from page 95 to page 101 inclusive.

Little more can as yet be said in regard to the more valuable metalliferous ores, further than has already been stated in describing the distribution of Lower Silurian strata, where it has been shown that the altered rocks of the Quebec group are largely developed. The indications of copper and nickel that were observed, although not sufficient to warrant outlay in mining, are still important enough to deserve attention, and encourage close investigation; while the vast development of the serpentines and associated rocks at Bluff Head, is an example of the usual mineral condition of the great metalliferous zone of North America.

Reports were current in the St. George's Bay country of metallic silver having been discovered on the northern shores between the Cape and Ship Cove; but there is much reason to doubt the accuracy of these statements. That silver may exist in combination with the lead ores of the country is highly probable, and that native silver may exist is at least possible; but if I may be permitted to judge from the character of some

specimens which were put into my hands as such, the fact is very questionable. These specimens are evidently an alloy or artificial combination, worked up with a design to imitate a natural production; but in which, so far as I have been able to ascertain, not a trace of silver appears to exist.

I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

His Excellency Colonel Hill, C.B.,
Governor of Newfoundland, &c. &c. &c.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, *March 9th*, 1874.

MAY IT PLEASE YOUR EXCELLENCY,—

In laying my Report upon the proceedings of the Geological Survey for 1873 before your Excellency, I beg leave particularly to draw your attention to the first and last parts of that document, namely, in the first place to the account given of the agricultural capabilities of the regions explored; and, secondly, to the description given of the mineral economics distributed over the same areas; as I feel convinced that much of the future progress and prosperity of this island will depend upon the system that is adopted, and means taken for the development of these resources. And in this connection, I hope it will not be deemed beyond the limits of my proper province to suggest, with all deference and respect, that some change should be effected, as to the disposal of wild lands for mining or other purposes. As the law stands at present, if I am rightly informed, a grant of land of one square mile, ostensibly acquired for mining, implies also the possession in *fee-simple* of the surface; whereas, an agriculturist or a lumberer is restricted to an area of 50 or 100 acres. My idea is, that a mining right should be altogether exclusive of any claim whatever to the surface, unless it is also specifically taken up for the purposes of agriculture; and, *then*, on the same terms that it would be by any other ordinary settler. In more advanced countries the agriculturist precedes the miner, and the latter is compelled to remunerate the former for surface damage done in

pursuit of mining operations. Here the case would be reversed in order, but the miner, if he owns the surface, would still be proportionally the loser, by the deterioration of the surface by his own works, which would probably interfere with the disposal or improvement of the land.

My belief is, that if large blocks of this territory were permitted to be sold to wealthy capitalists under certain restrictions whose interest would urge them to foster emigration and cultivation of the soil, a very few years would be required to convert the present wilderness into a flourishing settlement.

I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

His Excellency Colonel Hill, C.B.,
Governor of Newfoundland, &c. &c. &c.

CHAPTER XIV.

REPORT FOR 1874.—SURVEY OF THE GANDER RIVER AND LAKE—LETTER ADDRESSED TO HIS EXCELLENCY SIR STEPHEN J. HILL, K.C.M.G., &c. &c.—MR. HOWLEY'S SURVEY AND EXAMINATION OF PORT-A-PORT BAY AND PARTS OF ST. GEORGE'S BAY.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, *February 27th*, 1875.

MAY IT PLEASE YOUR EXCELLENCY,—

In my letter dated November 26th, 1874, an outline was given of the proceedings of the Geological Survey during the summer and autumn of that year, which I now beg to submit in fuller detail.

Mr. Howley's Report to me upon the western districts which he was instructed to examine, I beg also to lay before your Excellency, and it gives me much satisfaction to be enabled to state that the results of his labours are in the highest degree creditable to himself, and that the energy and perseverance he has displayed in working out the topographical features, together with the geological relations, of a country beset with many difficulties, can hardly be too highly commended. By comparing the map of St. George's Bay and Port-a-Port, which accompanies this, with any of the old surveys, it will be seen that nearly the whole coastline has been altered, the errors in the latter in many cases having been found to amount to several miles both in latitude and longitude, rendering such plans utterly worthless for the representation of geological structure, or as a base for laying off mineral or agricultural lands.

A tracing of my own work upon the Gander River country will also be furnished with this Report, upon which I have laid down a systematic plan for the subdivision of the land, for the approval of your Excellency in Council. Particulars descriptive of this map will be given farther on.*

DESCRIPTION OF THE GANDER RIVER.

The entrance to the Gander River is approached from the sea at Sir Charles Hamilton's Sound, by the great inlet of Gander Bay, lying nearly on a meridian for a distance of about 20 miles, contracting in its southerly course gradually from a width of 4 or

* See p. 368, Letter addressed to his Excellency Sir Stephen J. Hill, Nov. 26th 1874.

5 miles at the mouth to half a mile at Salt Island near the head, which is in lat. 49° 17′ N., and long. 54° 29′ W. The position of Salt Island having recently been determined by Staff-Commander Kerr, R.N., of the Admiralty Coast Survey, it was taken as a starting-point for our survey of the interior. The bay continues its southerly course above Salt Island, for about a mile and a half to the entrance to the main river, before reaching which two important streams are passed, one falling from the eastward, the other from the westward. These are known respectively as Barry's Brook and the North-West Brook. Above the entrance the course of the main river upwards bends a little to the westward for about 2 miles, where the tide-water terminates.

The following tabular arrangement of the courses and distances is given with a view to rendering the geography of the region in general, and of this great river in particular, as intelligible as possible. All bearings are from the true meridian:—

TABLE OF COURSES ASCENDING THE RIVER AND LAKE.

No. of Course.	Courses.	Distance. mls.	Distance. chs.	Rise in Feet.	Remarks, &c.
1	S. 22° 30′ W.	1	70	..	From entrance from bay to end of tide-water.
2	S. 36° E.	2	25	36	Rapids and current; strong rapids through a group of islands approaching the first pond.
3	S. 42° W.	1	16		
4	S. 70° W.	0	64	..	Across the first pond.
5	S. 22° W.	3	20	..	Up first pond to the narrows, where there is a very slight current.
6	S. 25° W.	2	45	..	Up second pond to where current begins.
7	West.	1	0	3	Along main channel, and strong current.
8	S. 41° W.	1	20	4	Through a group of islands; strong current reaches to the right side of Round Pond.
9	S. 83° W.	1	30	..	Obliquely across Round Pond to left side.
10	S. 28° 30′ W.	1	50	..	Up Round Pond to lower end of a group of islands where current begins.
11	S. 67° W.	3	20	6	General course through the islands: pretty swift current.
12	S. 87° W.	1	15	2	General course to the eastern projecting point of fourth pond.
"	"	0	20	..	To the middle of the fourth pond.
13	S. 38° 30′ W.	2	0	..	Up fourth pond to lower end of a group of islands.
14	S. 64° W.	1	0	2	Up swift current through islands.
15	S. 19° 30′ W.	1	35	2	Swift current.
16	S. 84° 30′ W.	2	0	2	Swift current most part of this course.
17	S. 41° W.	0	65	8	In this course there are a succession of small chutes or strong rapids.
18	S. 8° W.	1	24	10	Along a succession of rapids to the level and outlet of the great lake.
		30	39	75	Total distance by courses, and rise from the entrance at Gander Bay to the outlet of the great lake.

From the outlet a narrow arm bearing a little westward of south about 4 miles in length, with an average breadth of half a mile, leads to the great body of the lake which lies transversely to the general course of the river below. A prominent point called King's Head divides the narrow arm of the outlet from the great eastern arm. From King's Head the western portion of the lake bears south-westerly, where, at its widest part, it is nearly 3 miles across; but this expanse is divided by a peninsula and a group of islands on the south side, forming the approach to the main river on the north-west side, and the south-west arm on the other or south-east side. From King's Head a bearing S. 33° W., 3 miles 60 chains, reaches the extreme end of the peninsula, the islands lying on the north-west side of the line, from which point the main river arm bears upwards S. 73° W., about 4½ miles, with a breadth varying from a mile and a half or upwards to a little less than a mile, finally reaching a group of low, flat islands at the outlet of the main river. From the point of the peninsula S. 24° E., 1 mile 33 chains, reaches the entrance to another large branch of the river called the south-west branch, the course passing diagonally across the south-west arm, which carries an average width of a little over 1 mile.

At King's Head the entrance to the great eastern arm is rather over a mile wide, and the bearing up it is N. 81° E. for 11 miles, along which course the width varies from a mile to upwards of one mile and a quarter; and at the bend, at the termination of this distance, it widens to nearly 2 miles. The next bearing up the same arm is S. 39° E., 6 miles; then east 5 miles 60 chains; and finally S. 56° E., 2 miles and 25 chains to the extreme eastern end, where a good sized brook falls in from the south-eastward. The width of the lake in these last courses varies at different parts from a little over to something under a mile until taking the final turn, from whence it contracts gradually towards the eastern termination. According to our survey, the eastern extreme lies in lat. 48° 51′ N., long. 54° 22′ W., nearly.

The surface area of Gander Lake is between 40 and 50 square miles. In my letter of November 26th, 1870, it was also shown that I failed to strike soundings with 57½ fathoms of line, until reaching near to the eastern end, where bottom was struck at 51½ fathoms. Since that letter was written I have received a coil

of salmon twine, 90 fathoms in length, which I assume to be the depth found by a trapper I engaged to try the soundings; but this person, being unable to read or write, sent no further particulars. There are some curious phenomena observable upon this lake, dependent in all probability in a great degree upon its vast depth. According to the Indians and trappers who frequent the region, and who usually spend more or less of the winter months there, the surface is seldom frozen over during these months, and it is not until late in March or in April, when all the minor ponds are about to break up, that a thin pellicle of ice is formed extending from shore to shore. At that time, while the ground is saturated by the melting snow and falling rain, and every tributary swollen to its utmost capacity, pouring great volumes of chilled water on to the still surface of the lake, it seems probable enough that this excessive supply may form an upper stratum which, before amalgamating with the warm strata below, gets caught by a sharp frost, while many more degrees of lower temperature would be unavailing in the formation of an ice sheet, when the natural and normal circulation was uninterrupted. I was also informed that the river was unencumbered by ice rafts as other rivers even in the greatest freshets, notwithstanding that there are distinct evidences of the great lake rising above its normal level fully 9 feet, and this statement seems to be verified by the absence of any appearance of ice-grinding on the trunks of the trees, or of undermining of the banks, as is usually seen on all rapid streams.

While on this lake we were much struck by observing an irregular or spasmodic rise and fall of the water's level, without any apparent atmospheric cause. With a very steady barometer, and during an interval of calm and hot weather, the level of the surface was noticed to vary some 5 or 6 inches in the course of the day; and I observed on one occasion, at the entrance to the main river arm, that the current ran *towards* the river at the rate of about half a mile an hour. Charles Francis, the Indian guide, who was then in my employ, told me he had often witnessed this phenomenon, and that at the extreme eastern end of the lake he had once perceived a rise and fall in one day of fully a foot.

The main branch of the river at the extreme western end of

the lake bears upwards S. 28° W. for 5 or 6 miles, beyond which the general course is probably a little more westerly until reaching the head waters on the eastern side of the watershed of the Bay East River. See Report, 1870.

The south-west branch bears upwards from its outlet into the lake, very nearly due south, and was followed and measured for over 5 miles; but it appears to maintain the same bearing upwards for many miles farther. According to my Indian informant, the distance from the part we reached to the sources would take three days to travel following the valley, which may fairly be taken to represent a distance of between 80 and 90 miles; the lower part of which meanders in a southerly direction, as already stated, while the upper reaches bend south-easterly, encircling the tributary waters of the Gambo, as well as the minor streams which fall into the eastern arm of the great lake.

The principal tributaries of this great river in succession upwards are, Belman's Brook, Weir's Brook, Island Pond Brook, Joniton's Brook, Miller's Brook, Joe Batt's Brook, Home Brook, and the Salmon River, below the lake; and falling into the lake there are Square Wigwam Brook, Careless Brook, Hunt's Brook, Charlie's Brook, Joe's Brook, the North-East Brook, and the brook which falls in at the extreme eastern end. Besides these, there are innumerable minor streams and rivulets which fall either into the lake or the river below.

Geographical.

Following the course of the river upwards, the valley on either side presents alternations of extensive low-lying flats and gently swelling hills, covered with dense forest from bottom to top. In some cases the flats are wet and marshy; and on the sides of the hills the bold outline of a rocky cliff occasionally presents itself, but by far the greater portion of the surface is composed of detrital material, surmounted by a clayey and arenaceous, or sometimes marly soil. Belman's Brook joins the river on the left side of the 5th course of the table, and Weir's Brook falls in a little higher on the opposite or right side, both streams proceeding from lakes of considerable area some miles inland. The highest land seen in the valley is within the lower forks of these

streams, where a range of hills, densely wooded to the summits, rises pretty abruptly, especially on the southern side, to an elevation of about 400 feet over the level of the first pond. The timber of these lower reaches of the valley consists of the usual varieties of hardwood and evergreen trees, and amongst the latter pine and white spruce are very abundant, although not usually of very large dimensions, many of the more valuable trees near the banks having either been culled out or ruthlessly wasted, in a manner which I shall take occasion to mention at another place. Above the junction of these brooks, the surface is everywhere gently undulating and covered with forest, pine trees increasing in size and number as the ascent is made, until reaching Home Brook, which falls into the fourth pond on the left side, where a wood of white birch has replaced the original forest, long since swept away by fire. Some very large pines were observed on the reaches between Round and Fourth Ponds, groves of which timber are in ample abundance on both sides of the stream. A strip of white birch, which marks the course of a former fire, continues up the left side from Fourth Pond to the lower arm of the great lake, but amongst it and all around many stately pines still remain unscathed. Joniton's, Miller's, and Joe Batt's Brooks fall into the main river on the right side between Round and Fourth Ponds. They are each streams of moderate size, and flow for the greater part through a densely wooded and generally level country on the northern side of the watershed between the river and the eastern arm of the great lake. The largest tributary is the Salmon River, which joins about a mile below the outlet of the lake on the left side. It takes its rise in a multitude of small ponds and tarns to the northward of the Blue Mountain Tolt (to be described hereafter), the streams from which unite before entering a lake about 3 miles from the outlet, from whence it flows rapidly due east to its junction with the main river. Square Wigwam Brook and Careless Brook fall directly into the lake from the westward, the former joining at the northern or lower arm, the latter on the main western body of the lake. A fringe of densely wooded country, varying in width from less than a mile to about 3 miles, skirts the north-western shore of the lake from the entrance to the main river to Salmon River. This belt of wooded country is for the greater part level or undulating, of a good light

soil, and well supplied with pine, spruce, and hardwood; but, beyond it to the north-westward, the character entirely changes, and a wide expanse of barrens and marshes succeeds. Hunt's Brook, Charlie's Brook, and Joe's Brook fall into the eastern arm of the lake on the south side, the waters of the former stream interlocking with the sources of the Gambo. The North-East Brook joins on the north side at the bend near the eastern end of the arm, and proceeds from a large lake about a mile and a half inland; its course marking pretty nearly the boundary which divides the forest from the burnt lands.

From the midst of the great plain north-west of the main river and arm, a series of isolated mountain peaks arise, among which the most marked and conspicuous is the Blue Mountain Tolt or Mount Peyton,* the summit of which probably commands the finest panorama in the island. Two other peaks called the Big Look-out and the Little Look-out, are also well-marked features, although of much less altitude, and were found very serviceable as points in the triangulation. From the entrance to the main river a bearing N. 36° W., a little over a mile, reaches the summit of the Little Look-out, and the same bearing for 6 miles farther reaches the summit of Mount Peyton. The Big Look-out bears from the Little Look-out N. 13° W., 3 miles.

Mount Peyton rises to an altitude of about 1670 feet above the level of the sea, towering majestically over the vast barrens and marshes, which are dotted over by innumerable ponds and tarns, the sources of many streams flowing in different directions. The northern and north-eastern sides of this mountain present a nearly perfectly perpendicular face of some 700 or 800 feet sheer down to the general level of the plain, while the southern and western flanks slope abruptly but accessibly, and are partially and irregularly spotted with copse-like groves of stunted timber, through which, however, fire has made sad havoc.

From the base of the mountain the Little Rattling Brook of the Exploits takes its rise in one of the larger ponds, the stream from which can be seen from the summit wending its way to the westward; the upper waters of the brooks of Burnt Bay, Indian

* Called in honour of John Peyton, Esq., J.P., as overlooking the scene of many of his youthful adventures during the days of the now extinct race of Beothics or Red Indians of Newfoundland.

Arm, and Loo Bay are visible to the northward, while trending easterly are the waters of the Salmon River and Careless Brook of the Gander. The scene which presents itself on all sides from this isolated summit is indescribablv grand. Looking to the westward, the valley of the Exploits can be traced, with Hodge's Hill giving out its sharp and rugged outline to the sky; to the northward the Bay of Exploits is spread out like a map, with its innumerable islands and peninsulas; and away across the Great Bay of Notre Dame, till the faint loom of the hills of Cape St. John bounds the horizon on the one hand, and the distant points of the Fogo Islands break the uniformity of the ocean expanse on the other; to the eastward lies the green valley of the Gander, whose waters glisten here and there through the dark foliage of the forest wending their way to the sea; and the serpentine form of the eastern arm of the lake can be followed by the eye, stretching its silvery waters away towards Bonavista Bay; to the south east lie the rich alluvial burnt lands of the south-west branch and of the Upper Gambo; while far to the southward and south-westward the prospect is bounded by the hills of the watershed of the south-flowing rivers.

The ultimate sources of the main river rising at no great distance from the head of Bay D'Espoir, and flowing thence in a generally north-east course, must make a total length of not less than 100 miles in a straight line from its head to the outlet of Gander Bay; while the length of the south-west branch which interlocks with the head waters of the Gambo and the Terra Nova Rivers, cannot be much under 80 miles, following its sinuosities where it enters the great lake. The country drained altogether, consequently, would appear to be between 2500 and 2700 square miles.* Of this great expanse of country, a very large proportion, particularly eastward from the main river, is of rich and fertile soil, as amply testified to by its indigenous produce, which to a great extent consists of pine and spruce of a very superior size and description, intermingled with balsam fir, white birch, and poplar, the ground often being thickly matted over by an underbrush of ground hemlock. It is greatly to be regretted, however, that chiefly, if not altogether, from the careless use of fire on the part of trappers who frequent these regions, great damage has been done to those

* Probably nearer 3000 square miles.

noble forests. The great fire of 1867 appears to have originated in the region west of the main river, probably not far from the Great Rattling Brook of the Exploits, and proceeding easterly swept the forests on the main river above the lake; thence, crossing the south-west branch about 4 miles up its course, striking for the head of Hunt's Brook and some of the tributaries of the Gambo, struck upon the great lake near Joe's Brook, whence it crossed uninterruptedly to the sea at Bonavista Bay. The result of partial fires is observable besides at several other parts of the lake and river shores, which, in almost every case, could be traced to the remains of a shed, or what had been the temporary habitation of a trapper. Notwithstanding that great damage has, in this way, been inflicted over a large area, were the country now occupied by lumberers or settlers, a very large proportion of the timber might still be utilised, as we found upon trial, upon several trees, that they were still sound and solid, though dead; and even if unfit for lumber or spars, millions of cords of the best description of firewood might there be readily procured.

Within this region there probably is nearly, or quite, 700 square miles admirably adapted for the pursuits of agriculture, and not a very much smaller area still covered with pine and spruce, where a great trade in lumber might be prosecuted with profit to adventurers and immense advantage to the country at large. Were the tracts surrounding the head waters of the Gambo and the south-west branch to be taken into account, I have little doubt the area would be extended to 1000 square miles. In order to illustrate this, I have shown upon the map a systematic plan for subdividing the land, the surface of which is laid off in blocks of 6 miles square, each containing an area of 36 square miles. Of these suppose 20 to be reclaimable, there would be a total of 720 square miles. The plan adopted in the construction of this map was to take the meridian of Salt Island as a base-line upon which the whole system of blocks is erected. Following this meridian from Salt Island southerly, it will strike the eastern arm of the Great Lake on the north side about 2 miles west from the mouth of the North-East Brook, and on the south side at the entrance to Joe's Brook; thence continuing southerly to near the parallel of 48° 49′ N. lat. This parallel then forms a rectangular base up to about the longitude of 55° 1′ W. These two lines being

each divided into lengths of 6 miles, and lines extended from each subdivision to meet similar subdivisions on the respective parallels and meridians north and west, form the groundwork of the whole area.* For further subdivision it will be perceived that the northern boundary of blocks 1 and 2 is on the parallel of 49° 15′, which crosses the river close to the termination of the tide-water, and that the meridian of Salt Island, 54° 29′, intersects this line very close to the right bank at a point where a path was cut some years ago, known as Knight's Road. These blocks show the principle upon which lots for settlement ought to be arranged. First of all, the block is cut up into single square miles, and then again each mile is divided into six lots or equal areas of 100 acres, leaving a balance of 40 acres as a reserve for local roads in every mile. In order to give the lots a fair proportion of frontage to the river, the concessions include one mile of distance upon a parallel of latitude, while the lots are one-sixth of a mile upon a meridian of longitude. At the south-western extreme of the plan, No. 25 block is similarly subdivided as another example, and the same system can be applied, as best adapted to the peculiarities of the various localities, over the whole of an extended area. Each block is intended to represent a township, and the dividing lines between them are supposed to be reserved as main lines of road. As each lot, except where the frontage is broken by the river or lake, is supposed to be 100 acres of land, there will be an overplus of acreage in each unbroken township of 1520 acres which would be a reserve for local roads.

As nearly the whole of the area lying between the eastern arm of the lake and the main river, and a great extent of country on the north-west side of the latter, as well as on the south side of the lake, and for some distance up the south-west branch, is thickly grown over by magnificent pine and spruce, I cannot conceive any better possible plan for gradually improving the surface of the country and preparing it for regular settlement than by encouraging the introduction of capital to be applied towards utilising these splendid forests of timber.

Nor is the value of the timber the sole consideration, for it

* It will be observed that by this process no allowance is made for the convergence of the meridians; but the consequent different size of the blocks, in reality, is nevertheless inconsiderable.

will most assuredly be found that the opening up and settlement of the country will primarily be brought about by the operations of the lumberer, legitimately or otherwise, and many of those employed in clearing the forest will be among the very first permanent occupiers of the soil. With the timber trade, cattle, horses, and sheep will speedily be introduced; grain, grass, and roots will be cultivated; while labour will be in such demand that there need not be an unemployed hand throughout the year, from one end to the other of the colony, and *beggary* ought to utterly disappear from the land. Much has been said, and nearly as much published, about the propriety of letting out these vast lands as timber limits, which, according to some economists, ought to be reserved for the exclusive uses of fishermen. In answer to such objections, I am prepared to show that hitherto no fishermen have ever visited the parts I especially refer to for any purpose beyond procuring a supply of fur or venison; and such visits frequently, if not invariably, terminate by setting fire to the woods, and destroying more or less valuable timber. Next, I maintain that not only would the revenues of the colony be largely increased by the introduction of the lumber trade, but the fishermen themselves as a body would be those of all others who would reap the most benefit by it. It would (and it will) give ample employment to hundreds who would otherwise be idle, and would bring comfort and independence to many destitute, who, but for such occupation, would be seeking for charity; and finally, millions upon millions of feet of lumber will be saved and turned to account, instead of being, as hitherto, ruthlessly wasted or destroyed. This last assertion regarding waste is founded upon testimony that defies contradiction, and upon facts which I have myself witnessed; and here is an example which will apply generally:—A fisherman requires a spar for one purpose or another, and he straightway goes to the woods to procure one. In making his selection of the particular kind of tree which he requires, he cuts down, let us say as an average, *three* trees (frequently, however, many more) and, after fixing upon his quarry, he retires for that day. On the next or some future day he returns to dress up the selected tree, which will occupy time according to circumstances; and finally, he makes another trip, which may or may not be the last, accompanied by friends or

neighbours to help him to drag his spar to the river's banks or to the sea-shore. Now, in such a case it must be clear that at least two trees for one are wasted, which may fairly be considered as equivalent to nothing less than 1000 feet of lumber. Next, the question is, supposing there were lumbering mills established, amply supplied with horses, cattle, and all necessary adjuncts, would not the fisherman be supplied with the material he requires both better and cheaper by *buying* it direct from the manufacturer than by the aforesaid process? unless it be that he puts no value whatever on his own labour or that of his associates.

An advisable system for leasing these lands for lumbering purposes might be to let each township represent a timber limit, the lessee to acquire his right to the timber upon the said township for a term of years, either by direct arrangement with the Government, or as the highest bidder if the blocks are put up for auction. This, however, would be altogether independent of any right in fee to the land, which would be reserved for settlement; but the lessee of the timber ought nevertheless to be allowed every reasonable facility for acquiring such lands within the block as he may be disposed to purchase.

As each block, on an average, is calculated to contain 23,040 acres, it will be evident that such blocks as abut upon the lake will be deficient in area, but the many advantages to be derived for the transportation of material and other conveniences by proximity to the water, will probably fully compensate for that deficiency, and perhaps even enhance the value of such limits.

Provision ought to be made for the conservation of growing timber, by restricting the size of trees to be cut down for lumber to a certain minimum diameter—say for example 12 or 14 inches, except in the case of being required for the erection of a local habitation or in clearing the land for agriculture.

With respect to settlement, each township would contain 216 lots of 100 acres. If we suppose 100 acres to be capable of maintaining five individuals, each township would support a population of 1080 souls. A fair proportional share of stock on each of the said lots might be, say, one pair of horses and one yoke of oxen for draught purposes, two milch cows, and ten sheep. This would give an aggregate of 432 horses, 432 oxen, 432 cows, and 2160 sheep to

a township, exclusive of stallions, bulls, rams, &c., which to a great extent might be used in common. With the almost unrivalled capabilities the country possesses for grass growing, breeding and rearing of stock can hardly fail to become one of the great future industries of the province.

The total rise on the river to the level of the Great Lake has already been shown to be about 75 feet; and, as a great part of the natural course is still and moderately deep water, the impediments to the navigation of vessels, drawing from 5 to 6 feet, might be easily overcome by the construction of five or perhaps six locks. The positions of these would be situated thus: one at the foot of the rapids just above the tide-water, of say 18 feet, and another near the head of the large island in the lower group, of 18 feet more, which would rise to the level of the first pond. The next would be at the head of the second pond, of 7 or 8 feet, to the level of Round Pond. The level of fourth pond would then be reached by another lift of about 8 feet at the head of Round Pond. Lastly, one of 24 feet at the head of fourth pond, or two of 12 feet, the upper of which to be situated abreast of the lower chute, would rise to the level of the lake. By clearing out a straight channel at the shallower parts, and building slides over the stronger rapids, all difficulty in driving timber to Gander Bay would cease. In the event of the lands being opened up as timber limits, small steam vessels will inevitably be required for towing logs, and for other purposes on the lake. For these, good harbours can be found in the northern or lower arm at the entrance to the main river at Careless Cove, and at the south-west arm; but to reach the river mouth of the latter a channel must be staked off, as a large portion of the arm is very shallow. Hunt's Cove is also a well-sheltered place from all except strong northerly or north-easterly gales; and there is an excellent harbour at the extreme eastern end of the lake, where there are also two coves admirably adapted for booming in logs. As the distance from the eastern head of Gander Lake to Freshwater Bay does not at most exceed 9 miles, and the maximum height of the land between does not appear to be over 150 or 200 feet above the sea, a tramroad might be laid without great difficulty, by which a large amount of timber or other produce might be transported to Bonavista Bay; while a saw-mill on the largest possible scale, at or near the outlet of the Gambo, would,

I have every reason to believe, be in a position to carry on a most prosperous business.

Should the suggestions I have ventured to offer be carried into effect, and the regions I have attempted to describe be opened up to trade and settlement, I propose, with your Excellency's permission, to give the district or county the name of Hill, in honour of your Excellency's administration as Governor of the colony.

Geological Features.

In my Report for 1871, while reviewing the facts ascertained in the region of Sir Charles Hamilton's Sound, mention is made of the occurrence of a set of wrinkled and altered calcareous slates at the Indian Islands which contain fossils, chiefly corals and encrinites, apparently typical of a horizon near the top of the middle or base of the Upper Silurian system. It is also remarked, at page 32 of the same Report, that the rocks of the Indian Islands form a synclinal, and rise again on the south side of the strait, spreading over a wide area between Ragged Harbour and Gander Bay. Corresponding rocks with fossils come up at Bussey's Point on the west shore of Gander Bay, but the rock is there so highly altered as to render the organic contents extremely obscure; and those that could with any certainty be identified were the remains of stems of encrinites, some of which were of large size. Above this point no fossils whatever have been discovered to give a clue to the geological horizon, either in the bay or river, but the lithological resemblances and many characteristics are still preserved in most of the exposures on the river and at several parts of the great lake. At Salt Island and the shores abreast, the general strike of the rocks is nearly north-east and south-west, and the attitude either vertical or dipping at a very high angle towards the south-east. These rocks consist of blackish and dark grey slates, with occasional strong beds of fine conglomerate, most of which are more or less calcareous. The strike carries these strata obliquely across the course of the river, but they turn more southerly at the lower rapid or "Bread and Cheese Point," where the dip is S. 62° E. $<$ 70°. Following the river upwards, slates continue on the right bank, where they exhibit several sharp folds and undulations on a general strike nearly north and south; but the left side of the river

at the rapids of the islands is crowded with huge masses of a hard crystalline yellow-weathering rock, apparently a dolomite, while the exposures a little higher up and upon the same shore of first pond consist of dark green, hard epidotic rock, frequently breccious which weathers brown, with diorite. The character of the exposure on first pond bears a general resemblance to members of the Quebec group, as described in former Reports; but above that pond the slates have more generally the aspect of those at the mouth, and these continue uninterruptedly up to the chutes at the upper rapids, where diorites and some very hard altered sandstone or quartzite come in. The slates were observed to be everywhere very ferruginous, and many surfaces were seen speckled in a remarkable manner by small dots or cavities, encrusted with peroxide of iron; while others were scored by a set of well-defined lines, as perfectly parallel to each other as though they had been drawn with a rule, and likewise so speckled. With these, fine conglomerates occur, which are always slightly calcareous. King's Head and the northern shore opposite as far as Careless Cove present abrupt or precipitous cliffs from 20 to 30 feet high or upwards, consisting of very ferruginous slate with bands of calcareous conglomerate and some altered sandstone, innumerable white quartz veins, much iron-stained, running in the strike. Great masses and many nodules of radiating iron pyrites are associated with these rocks. On the southern side of the lake, between Hunt's Cove and the south-west arm islands, the shore consists of low cliffs of mica slate, the surfaces of which are smooth and silky, with numerous quartz veins running for the most part in the strike. These rocks are greatly corrugated, but their general strike from the islands of the south-west arm is nearly south up the valley of the south-west branch of the river. On the east side of Hunt's Cove there are some fine-grained bluish or blackish clay slates, mixed up with the soft silky mica schists, which are probably suitable for hone-stones. These run about north-east and south-west with a north-westerly dip, and appear to be underlaid by mica slate of a coarser quality, which shows itself a little to the eastward, apparently striking for a slightly projecting point upon the north side of the lake, a little over half-way between King's Head and the great southern bend. Immediately west from this point, some red slates show themselves on the banks, succeeded by green, and

red and green alternating, the latter colour prevailing towards King's Head; but to the eastward of the same point the shore is occupied by diorites, serpentines, and chloritic rocks for the next two miles, at the end of which contorted and coarsish mica schists again crop out. Farther up the lake micaceous slates still prevail, many surfaces of which are characterised by the presence of crystals of staurolite, precisely resembling the slates of the country near Round Pond of the Bay East River.* These or similar slaty rocks with some quartzites and diorites occupy the northern shores of the eastern arm, nearly all the way to the entrance of the North-East Brook, and also for some distance on the south side, but a marked change takes place on that side about 2 miles west from the mouth of Joe's Brook, where the rock is a fine-grained granite. The points on both sides eastward of the two above-named brooks, display sections of corrugated and contorted gneiss, which I have no doubt to be of Laurentian age, connecting with the Laurentians of the northern seaboard of Bonavista Bay.

The barren country on the north-west side of the main river, extending across from the Little Look-out to Mount Peyton, and probably for some distance beyond, seems to be entirely composed of a homogeneous red felsite, in which no stratification is observable at any part of its distribution. The rock disintegrates freely where exposed to the weather, and at the summit of Mount Peyton and other of the higher elevations is rented by parallel joints into great cubical-shaped blocks; while the sides are thickly strewn over by broken and worn débris. The whole region around Careless Brook and Cove is covered by a thick deposit of a brick-red sand derived from this rock.

It will be perceived from the above statements that the structural evidences, so far as they go, seem to indicate the probability that the rocks so largely distributed over the lake and river country are of two horizons; one apparently representing a portion of the Quebec group, the other a continuation of the middle or Upper Silurian slates of the Bay of Exploits and Sir Charles Hamilton's Sound; but as those evidences are mainly dependent upon mineralogical or lithological character, at all times unsatisfactory where there is obscurity in the stratigraphical sequence, it will be advis-

* See page 231, Report for 1870.

able to defer expressing too confident an opinion upon these points for the present, trusting that further investigation may lead to more definite and decided conclusions. The gneissoid rocks which bound these formations on the east, there is very little doubt, are of Laurentian age, corresponding with those described in my Report for 1869, p. 194; but the amorphous red rock which bounds them on the west I am now more inclined to consider as a vast intrusive mass, intersecting the country diagonally in a north-east and south-west direction, probably connecting with the granites and syenites of Round Pond and the Partridgeberry hills to the south, and those of Long Island and other islands of Exploits Bay to the north. Should the proposed railway survey be carried through towards the Exploits in the direction I have indicated as probably the most favourable line for construction, much of the present doubt which prevails regarding our geological information will, in all likelihood, be removed, and fresh light be thrown upon our knowledge as to the presence or absence of metals or minerals of economic importance.

Economics.

The presence of serpentines on Gander Lake may be taken as favouring the probability that some of the more valuable metallic ores may exist in the neighbourhood; but with the exception of great quantities of sulphuret of iron, none were met with on our survey. Some of the quartz veins in the ferruginous slates have somewhat an auriferous aspect, and may be worthy of thorough investigation. Some specimens were collected for analysis, but no opportunity as yet offered, of having them submitted to a chemical test. Bog iron ore was observed scattered in tufaceous masses at several parts of both the river and lake.

A beautiful grey granite can be procured at sundry parts of the eastern arm, towards the head of the lake, especially at the mouth of the brook next west from Joe's Brook, and also on the south shore directly opposite the North-East Brook. The stronger beds of sandstone and the conglomerates will be found serviceable for ordinary rough building, and can be conveniently procured for constructing locks or other buildings on the river.

Near Hunt's Cove some of the harder beds interstratified with

the slates, seem to be of an excellent quality for whetstones; and good flags are not uncommon among the same strata.

Should a survey be instituted for the purpose of laying off these lands for lumbering limits and settlement, I have no doubt that one of the first results will be to greatly extend our knowledge of the general structure of the country, and to further the development of its mineral resources.

I have the honour to be,
Your Excellency's most obedient servant,
ALEXANDER MURRAY.

His Excellency Sir Stephen J. Hill, C.B., K.C.M.G.,
Governor of Newfoundland, &c. &c. &c., St. John's.

LETTER OF A. MURRAY, ESQ., F.G.S., DIRECTOR OF THE GEOLOGICAL SURVEY, TO HIS EXCELLENCY SIR STEPHEN J. HILL K.C.M.G., C.B., UPON THE RESOURCES OF THE INTERIOR OF NEWFOUNDLAND.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, *Nov. 26th*, 1874.

MAY IT PLEASE YOUR EXCELLENCY,—

As the investigations of the Geological Survey during the past season have revealed certain facts regarding the natural resources of the Island, which may prove of the highest importance to its future prosperity, I beg leave to submit the following outline of the late proceedings of that Survey for your Excellency's consideration.

In order to economise time, our operations were divided, and two parties formed, one of which was conducted by my assistant, the other by myself. I instructed Mr. Howley to continue the survey of St. George's Bay and Port-a-Port country which was commenced last year, while I proceeded to Gander Bay, for the purpose of examining and surveying the valley of the Gander River, and the country surrounding its great inland waters. The result of both these surveys will be more fully given in the Report I am now engaged in preparing, to lay before the Legislature.

The entire coast of Port-a-Port Bay was re-surveyed by Mr. Howley, all previous representations of which were very greatly in error; he measured all the principal streams in the same

region, and connected the whole upon a continued series of triangles from the heights and most conspicuous points. He also surveyed Crabb's Brook and the coast-line, for a considerable distance, on the south side of St. George's Bay, and made an examination of the Cape Anguille range of hills; and finally he examined the coast sections between the Great Codroy River and Port-au-Basque. His work has materially advanced our knowledge of the true geological structure of those regions, which hitherto was very obscure; and he has made a most valuable collection of fossils and minerals to illustrate the same, which are now deposited in our museum.

My own operations on the Gander River country have added another prominent geographical feature to the map of Newfoundland, and another step has been made in advance towards attaining a general knowledge of the distribution of the geological formations.

The Gander River drains an area roughly estimated of about 2500 square miles. The lower reaches proceed from a great lake of a serpentine form, extending in an east and west direction lengthwise, between the meridians of 54° 21′ and 55° W. longitude. The width of the lake varies at different parts from 1 to upwards of 3 miles, and its surface area amounts to between 40 and 50 square miles. This great lake is fed from the south-westward and the southward by two large streams; one, which is called the main river, taking its rise at no great distance from the head of the Bay D'Espoir, and connecting with the waters on the eastern side of the watershed of the Baie D'East River, described in my Report for 1870; while the other, which is known as the south-west branch, flows through a vast table-land which extends towards the waters which fall into Bonavista Bay, apparently encircling the whole of the Gambo and its tributaries. Besides these two streams, there are innumerable minor brooks and rivulets which add their tribute on all sides. The normal surface of the lake is only about 70 feet above the level of the sea, and it is easily accessible for canoes or small boats at all times by the river's course, the only interruptions being a set of rapids a little below the outlet of the lake, and another set not far above the tide-water of the bay, neither of which, however, involve portaging or difficulty of any kind whatever. Long stretches of still water, commonly called ponds by the trappers, constitute the

greater part of the river's course, and these are connected by gentle currents, which, but for the shallowness of the water, which sometimes spreads over an immense width, would be scarcely perceptible. As to the lake itself, one very remarkable feature is the enormous depth of the main body, of which I attempted to get soundings, but failed to strike bottom with 57½ fathoms of line, and it was not till getting nearly to the extreme eastern end that I at length got soundings of 51 fathoms.

Except where partially denuded by fire, the whole valley of the river, the shores over the lake, and the banks of the tributaries, are all densely clad by forest, amongst the most conspicuous trees of which are pines, to all external appearance of the finest description. Below the head of the first pond, or for about the first ten miles from the entrance, much of this valuable timber has been culled out for local purposes by the residents on the sea-coast, but above that part they still remain in all their pristine vigour, even close to the banks. Upon the south-west arm, and at various parts of the lake, groves of pine may be seen where the average girth of the trees is not much if anything less than 9 feet, and where many individual trees will reach to 11, 12, and even 14 feet. On about 1 acre of surface I measured fifteen or twenty trees, the diameters of which varied from 2½ to 4½ feet, and these, moreover, were straight, tall, and sound, with stems running up symmetrically, for upwards of 50 feet, without knot or branch.

What the entire extent of this timber country may be, it is impossible to state with accuracy without making a survey for that especial purpose; but from what I have seen on the surveys I have already made, and from all that I could gather from the Indians and trappers who frequent these regions, I conceive there must be an area of not less than 500 square miles, worthy of being laid out as timber limits, where an immense lumber trade might be carried on successfully. It is true that over a large tract great destruction has been occasioned by fire, and this is particularly the case on the great plateau of the south-west branch, where the timber was formerly of the very best quality; but were the land taken up even now, it would be found that many of the trees, though dead, are still sound and fit to be utilised, while the evident fertility of the soil would amply repay the nolders of the land, when the supply of its indigenous produce was exhausted.

The natural facilities for carrying on lumbering operations in this country could hardly be exceeded. A channel might easily be cleared out at comparatively small cost in the shallower parts of the stream, by which logs could be rafted or driven to the sea at Gander Bay; and by the construction of three or perhaps four small locks, steamers or craft of considerable size might have ingress to the great lake. From the eastern end of the lake to the sea at Freshwater, Bonavista Bay, the distance does not exceed 9 miles, and the maximum level of the land between, being apparently not much over 150 feet, a tramroad might be built without more difficulty than that occasioned by clearing up the surface where it would pass through. The eastern termination of the lake is well suited as a harbour, and the coves at its head are admirably adapted for booming in timber. Water power can be obtained at numerous places on both sides of the lake for driving machinery, where saw or grist mills might be erected; and hardwood fuel can be obtained in ample abundance at many parts for steam power when required. Large steam saw-mills, at Freshwater in Bonavista Bay on the one hand, and at the head of Gander Bay on the other, might be in constant operation for years to come, and thousands of people might be usefully and profitably employed. Were the country once opened up to the lumber trade, and the great lake used as a means of communication, not only the timber of the Gander waters, but that also from the heads of the Gambo would come to its shores, to find its way ultimately to the sea, either by the river or the tramroad as circumstances might require.

The establishment of the lumber trade in these regions, however, would only be a preliminary movement towards the ultimate permanent settlement of the land. The soil over an enormous area is rich and fertile, the surface level or gently undulating, and roads could be easily constructed in almost all directions. That this country is capable of raising all or most of the cereal crops in ample abundance, I see no manner of reason to doubt; and for the produce of roots or grass it could hardly be excelled. Were means taken to settle this region in a regular and systematic manner, by laying off townships, intersected by reserves for roads, as in Western Canada, a very few years would be required to turn it into a great grazing country, where cattle and sheep would be raised for exportation.

I am at present engaged in constructing a map of the country

referred to above, upon a scale of 1 inch to 1 mile, upon which when completed I intend to represent full particulars, together with a plan I should recommend for the subdivision of the land. I hope shortly to be enabled to furnish your Excellency with a tracing from this map, which I apprehend will be more intelligible than any written description. Mr. Howley is also similarly employed in mapping out his work in St. George's Bay and Port-a-Port. As these latter are the only correct representations of the coast-line ever yet produced, and the surrounding regions are likely to become important as mining localities, I intend with the approval of your Excellency in Council to publish these plans upon a reduced scale of 4 miles to 1 inch, upon the surface of which all details, topographical and geological, will be represented.

I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

To His Excellency
Sir Stephen J. Hill, K.C.M.G., C.B.,
Governor of Newfoundland, &c. &c. &c.

REPORT OF J. P. HOWLEY.

GEOLOGICAL SURVEY OFFICE,
March 16th, 1875.

SIR,—My investigations during the past season have, in accordance with your instructions, been chiefly directed towards the Peninsula and Bay of Port-a-Port, together with a large portion of the mainland on the eastern side of the same bay. A portion of the southern coast of St. George's Bay and the interior country between it and the Codroy River were also examined towards the end of the season.

As the purpose of the examination of the Port-a-Port country was to gain an accurate knowledge of the geological structure, and particularly the distribution of the Lower Silurian formations so largely developed in these regions, a careful topographical survey of the whole coast and the principal rivers was found to be abso-

lutely requisite, as the inaccuracies of the old charts and plans of those parts were even more conspicuous and embarrassing than those of St. George's Bay, of which you make mention in your Report for 1873.

Our measurements and bearings were taken as in former years by Rochon's micrometer telescope and prismatic compass, but the whole work was kept in check by a connected system of triangulation with a good theodolite on all the principal elevations and conspicuous points, the result of which, when plotted to a scale of 1 inch to 1 mile, has proved very satisfactory. Besides the whole inner coast of the bay, the courses of two of the principal brooks were scaled, viz. those hitherto known as Fox Island Brook and Coal River, the former for between 13 and 14 miles, the latter for nearly 20 miles. Several minor brooks also on both sides of the bay were ascended as far as practicable, and frequent excursions were made to the tops of the higher mountains and across various parts of the peninsula.

Returning homewards in the fall of the year, I measured the coast-line on the south side of St. George's Bay between Crabb's Brook and the "Highlands," a distance of 8 miles. Crabb's Brook was dialled for 16 miles, 4 chains, and 41 links; an excursion was made on foot across the Cape Anguille range of hills from the Highlands to the Great Codroy River, and finally the coast was examined southward from the Codroys to Cape Ray, where my season's field-work ended. Since then, as you are aware, I have been engaged in mapping these particulars.

This extensive topographical work, while indispensable for the correct representation of geological detail, necessarily occupies much time which might be otherwise spent in the more appropriate operation of following out the structure, and had I been supplied with an accurate map to record the observed facts upon from time to time, the results of the season's work might have been much more extensive; nevertheless, I hope you will find upon a strict scrutiny of the map and sections I now beg to submit for your inspection, that a considerable step has been made in advance towards a correct knowledge of the geology of the country.

Geographical and Agricultural.*

A glance at the map will show that the peninsula of Port-a-Port is connected with the mainland merely by two narrow beaches of coarse gravel, with a salt-water pond within, which, by a depression of the surface of about 12 or 14 feet, would be altogether submerged, and the peninsula would become an island, as it evidently has been at no very remote date. The name by which the locality generally and the small settlement here is distinguished, viz. "The Gravels," is derived from the existence of these beaches. In your Report for last year, the construction of a canal through these Gravels was recommended, the necessity for which was still more forcibly impressed upon my mind while in the neighbourhood last summer. By such a construction in many cases a voyage of nearly 100 miles would be saved; it would afford a safe retreat for fishing and other craft in both bays, and in the event of mining operations proving successful in the vicinity, will be almost or altogether indispensable. At the instigation of the Very Rev. Thomas Sears, P.A., an attempt was made by some of the residents at the Gravels to effect an opening between Port-a-Port Bay and the pond through the northern beach; but, owing to want of funds or lack of energy or encouragement, was finally abandoned. It is said that some of the older inhabitants remember the existence of an opening through the southern beach from St. George's Bay, sufficiently large to admit the entrance of large-sized fishing skiffs into the pond, but which was finally closed up by the wreck of a small vessel in the gut while endeavouring to reach the harbour during a storm. A similar instance of the extinction of a boat harbour occurred about twenty-five years ago at no great distance from the Gravels and by the same means. A large vessel, driven to seek for shelter from a gale of wind, and misled by the charts, which represented a harbour on the western side of Indian Head, stood for the channel and struck there, and soon became a total wreck, which, obstructing the free ingress and egress of the sea, occasioned the silting up of the entrance altogether, which is now obliterated, the former harbour being a detached pond.

A right-angled triangle, of which the northern shore of St.

* All bearings are from the true meridian.

George's Bay would be the base, between the Gravels and Cape St. George, and the extreme end of Long Point the northern apex, will enclose the whole of the Port-a-Port peninsula or third area of your Report for 1873, inclusive of the eastern and western bays. These two bays are formed by a long low point called Shoal Point, which juts out nearly at right angles to the trend of the southern shore of the bay, and almost in a due north and south line. The land area, including Red Island, which lies off its western shore, is about 157 square miles. The bays of Port-a-Port are bounded on the north-west side by a strip of land between 2 and 3 miles across at its base, where it leaves the main body of the peninsula at Black Head in West Bay, which runs thence in a north-easterly direction, tapering gradually as it approaches its termination in a low ledge of rock called Long Point in lat. 48° 47′ 12″ N., long. 58° 46′ 23″ W. The hypothenuse of the triangle aforesaid faces the Gulf of St. Lawrence, with a distance in a straight line from Long Point to Cape St. George of 32 miles; while the base from Cape St. George to the Gravels, drawn direct, measures 26 miles.

The middle or Shoal Point, which divides the East and West Bays, extends, as already stated, due north 6 miles from the mainland on the south side. It is low and flat, covered for the most part with peat bog, and a shoal projects from its termination fully 3 miles out into the bay.

The general trend of the eastern coast of Port-a-Port and beyond, although interrupted by sundry curves and indentations, is about N. 20° E. from the Gravels to South Head of the Bay of Islands. Near the former place the coast is bounded by cliffs, averaging 30 or 40 feet in height; but farther north the shore is low and shelving at many parts, with wide lagoons and boggy and marshy banks, which are formed at the outlets of various streams; and there is a wide extent of flat land in the vicinity of Fox Island Brook. Following the coast northerly from Fox Island Brook, cliffs of moderate height alternating with sand-beaches are met with until approaching Bluff Head, when they become lofty and precipitous, Bluff Head itself rising almost vertically from the shore to an altitude of 1600 feet. These lofty cliffs continue uninterruptedly to Lewis Brook, but beyond it they are of moderate height, and the land near the shore is flattish or undulating till reaching the entrance to the so-called Coal River.

The mountain range, locally known as the Lewis hills, which terminates on the coast at Bluff Head and Lewis Brook, strikes obliquely into the country, thence in a north-easterly course, bearing towards the Blomidon range on the south side of the Humber Arm. Immediately north from Coal River a set of bare and peaked hills rise abruptly from the shore, frequently reaching an altitude of upwards of 1000 feet, and the whole coast continues of the same rugged and precipitous character till reaching South Head at the entrance to the Bay of Islands.

The east and west bays of Port-a-Port are eligible as harbours during the summer months; but the wide expanse of surface, especially of the former, renders them unsafe in boisterous weather, especially during northerly or north-easterly gales. At a place called Piccadilly, within the western bay, however, there is a secure harbour at all times and in any weather.

The principal streams which empty into Port-a-Port Bay are Fox Island or Bennois Brook, Bluff Head Brook, Lewis Brook, Molly Ann's Brook, Rope Cove Brook, and Coal River, all falling in on the east side, besides several minor rivulets; while a few moderately large-sized streams and several minor ones fall into West Bay. Of these, Bennois Brook and Coal River, being the largest and most important, were surveyed. Bennois Brook takes its rise in a series of small streams among the Lewis hills, which, uniting in a deep gorge, flow south-west for 8 miles in nearly a straight line, at the end of which it turns sharply to the west, running generally on that course, but with many sinuosities, 6 miles more, when it enters the sea. At the upper part of the last course the river is very narrow, rapid and broken by small falls, and is enclosed between high rocky cliffs: but the valley widens rapidly on the descent, and at the outlet there is a triangular area of flat land of about 60 square miles.

Serpentine River * takes its rise about 2 miles north of Little George's Pond of Harry's Brook, described in Report for 1873. It flows thence in a straight line north-west by west for 8 miles

* I propose to call this stream "Serpentine" instead of "Coal River," as being more appropriate. The latter term has doubtless been given under the erroneous impression that coal existed in the valley, which it does not; but the course of the stream being sinuous, and the nature of the rocks through which it flows being magnesian, renders the term "Serpentine" peculiarly applicable.

into a large expanse, entering at the eastern end, which I have named Serpentine Lake. This lake lies nearly upon the same course lengthwise, and is 5 miles 30 chains long by an average width of 70 chains. Its surface area may be about 3000 acres. From the outlet of the lake the general course is nearly north-west for 6 miles, but in this course it makes no less than thirty sharp turns in the upper five miles, and is mostly still water, which at some parts is very deep; the banks being low and composed of yellow clay, fine sand, and gravel. Within the lower part of the same course there are two falls of about 10 feet each, and several small chutes with shallow water. From the end of the last course the stream turns abruptly S.S.W., in which direction it flows for 1 mile 60 chains; and thence, turning due west for 2 miles 20 chains, it finally reaches the sea. The lower course of the stream is navigable for small boats and canoes for only about half a mile at high water, above that distance it being shallow and rocky, and broken by many rapids and chutes. This stream receives tribute from four brooks of considerable size, and several smaller ones. The two principal of these join near the outlet, and not far above the tide-water, coming from opposite directions; the one on the north side flowing through a low flat valley bounded on each side by lofty hills, which extend across to York Harbour, Bay of Islands. The one on the south side proceeds from the Lewis hills. The largest of the upper tributaries takes its rise amongst the Blomidon range, and flows rapidly along the south-western flanks of the same, its lower courses being generally parallel with the river but running in the opposite direction, falls into Serpentine Lake at its lower extremity. The fourth tributary joins on the left side about half-way between the great bend of the river and Serpentine Lake, flowing northerly from the Lewis hills.

A large portion of the peninsula, and by far the greater part of the mainland on the eastern side of the bay, is high, rugged and barren, and there are portions, more especially where the rocks are magnesian, where the vegetation is either very scant or absent altogether. The other mountain summits also, although calcareous, are usually bare, but the flat country where the sub-soil is a combination of the ruins of arenaceous, calcareous, argillaceous, and trap rocks, is often rich and fertile. This is

notably the case over a large tract of the peninsula around West Bay, and at the head of East Bay. It was estimated that there may be in the peninsula alone, nearly 100 square miles of area available for agricultural pursuits. In the region surrounding West Bay a tract extending over at least 45 square miles is level, densely wooded, and is intersected by several brooks of good size. At some abandoned clearings near the sea-shore, the rank luxuriance of the grass that grew there was most remarkable; while the timber produced over the other parts of the area was of good quality, consisting chiefly of white spruce, balsam fir, and yellow birch (commonly known as witch-hazel). Pine was not observed, and if it exists is scarce.

The valley of Bennois Brook contains an area of about 60 square miles, at least one-half of which might be reclaimed; but there is a good deal of marshy ground over the remainder. The country is well timbered by the usual varieties of trees; and on the lower reaches of the river and the numerous islands near its outlet, there are very fine groves of poplar, and a species of ash resembling the American white ash, a tree unknown on the eastern side of the Island, which may probably be found serviceable timber for various purposes. The only other parts where this peculiar species of ash was observed to grow were on Serpentine River and on Harry's Brook of last year's survey.

The valley of Serpentine River, like that of Bennois Brook, is very wide at the entrance, but it contracts rapidly as it approaches the mountains. The whole area within the hills is about 58 square miles, inclusive of the flat marshy land, which stretches across to the Bay of Islands, and the narrow fringe which skirts the mountains towards Lewis Brook. Much of these lower lands are of good soil, more especially on the banks of the river, and along the base of the mountains, where the surface is generally level and dry. In addition to the usual varieties, pine and tamarack may be enumerated amongst the indigenous timber. These latter trees, although less abundant than the others, are nevertheless in considerable quantity, and some of the former reach a great size. I measured one pine which had a circumference of 12 feet, and there are many varying from 2½ to 3 feet in diameter.

South Shore of St. George's Bay.

In common with the other larger rivers of which a Report was given last year, Crabb's Brook takes its rise among the Long Range mountains. It issues from the mountains in two large streams leaping and foaming over precipitous falls and masses of fallen rock, through deeply cut gorges with high perpendicular cliffs on either side until reaching the level country at the base, where they unite, and thence flow in a general course about north-west by north for a distance a little over 16 miles to the sea. The length of this river along its course from its exit to the mountains is somewhat less than that of the streams surveyed last year, partly in consequence of its being less sinuous, but more particularly from the circumstance of a bend to the westward occurring in the Long Range near where the river debouches from the mountains.

The valley of Crabb's Brook is generally level or gently undulating, and is densely covered by the prevailing forest timber, much of which, particularly the yellow birch, is of large size and apparently of excellent quality. The soil appears at all parts to be even superior to that seen on the banks of the brooks examined last year, and for about 3 miles of the lower reaches the stream passes through a wide expanse of level country, with many low flat islands in its midst, all of which when cleared yield spontaneously the most luxuriant crops of wild grass, which are naturally irrigated annually by the freshets of spring.

Proceeding along the coast of St. George's Bay from Crabb's Brook southerly, we come to a stream called River Brook at the end of about 2 miles. This also takes its origin among the mountains of the Long Range, and flows generally parallel with the other streams, passing by the north-eastern end of the hills of Cape Anguille in its course towards the sea. About 2 miles above its outlet it expands into a large pond or lake. Southerly from River Brook and between the coast and the north-western slope of the Cape Anguille hills the country is locally known as the "Highlands." The term is appropriate, as the scenery of the back country is quite of the Highland type; and the inhabitants of the coast at that part are descendants of the Scottish Celts, who

still retain the language of their ancestors. This fringe of the coast from Crabb's Brook southward for over 8 miles, is a splendid tract of agricultural land, level, dry, and free from marsh. Grain crops and grass flourish luxuriantly wherever grown, and, as an instance of its capabilities as a grazing country, I was informed by one of the residents that he had cut hay off one field for twenty consecutive years without ever having broken up the ground since the time of first clearing.

The ascent of the Cape Anguille range was made by a very rough footpath, which leaves the coast between 3 and 4 miles southerly from River Brook, and is used by the respective inhabitants of Codroy and Channel on the one hand, and those of the Highlands and Crabb's Brook on the other, as a means of intercommunication. It follows the line of the coast for about 2 miles where the ascent is gradual and the country comparatively level; and then turning off about S.S.E., strikes up the slope of the mountains, reaching, in a little over 2 miles, the sources of a small stream and a wide marsh, having there attained an altitude of 1706 feet above the level of the sea. Following the same course, still ascending for 3 miles more, the maximum elevation is reached, which, according to the readings registered of the aneroid, was 1862 feet.

From this point the descent was made in a general S.S.W. course about 9 miles to the valley of the Great Codroy River, which was struck upon the northern branch about 2 miles above the main fork. See Report 1866.

The sides of this range of hills are frequently densely wooded, with the usual varieties of timber, but towards the top the trees become more or less stunted or dwarfed, while the extreme summits, which are in some cases level over wide spaces, are usually either bare or grown over only by low ground spruce, through which the effects of fire are but too perceptible. Towards the coast on the north-west side, and the Codroy valley on the other, the flanks of the hills are very steep, and sometimes precipitous, but the general contour is nevertheless rounded and smooth, offering a marked contrast to the neighbouring bold and rugged outline of the Long Range. The numerous little brooks which abound on both sides of the watershed, taking their origin from the ponds, tarns, and marshes among the mountains, have cut

deep precipitous gorges in their courses, particularly towards the outlets, which are frequently impassable, rendering a considerable detour inland unavoidable to get from bank to bank.

The table-land on the summits of these hills, although too lofty and exposed for ordinary tillage, seems nevertheless to be very well adapted for grazing ground, especially for sheep, and the wild grass which grows spontaneously in many of the little glens and sheltered places is of a very luxuriant description.

Distribution of the Formations.

In last year's Report, beginning at page 335, a general outline is given of the distribution and succession of the Lower Silurian strata, as developed in the country surrounding Port-a-Port Bay. These have now been more fully investigated in detail, and the result has thrown much light upon the obscurity which hitherto has prevailed regarding the general structure of the entire region.

In the Report just alluded to, the lowest measures exposed at the Gravels are described under the head of Potsdam and Calciferous formations, in one very regular section of 1594 feet thickness. The lower measures were supposed to be of Potsdam age, from the strong lithological resemblance they bear to rocks of that age at other parts of their distribution, rather than palæontological evidence, fossils being either absent or too obscure for satisfactory identification. But the succeeding beds, which follow with perfect regularity, are, especially towards the top of the series, well charged with highly typical organic remains of the true Calciferous. According to the estimate made this season, the total thickness of the two groups taken together cannot be much under 3000 feet. On the eastern side of the bay, north of the Gravels, the following section of the Calciferous rocks was measured in the ascending order, on a general dip N. 31° W. < 21°:—

Section No. 1.

	Feet.	In.
1. Thick-bedded light grey limestone, with thin shaly divisions, occasional beds of pale drab close-grained arenaceous limestone, sometimes tinged with red; obscure fucoids at base	100	3

	Feet.	In.
2. Alternations of thick-bedded grey limestone and thin nodular beds, divided by greenish shaly layers; many obscure fossils exposed on weathered surfaces of harder beds. Several turbinated shells, probably *Macluria*, with *Orthis*, *Leptæna*, *Encrinite stems*, and large *Orthoceratites*, could be recognised. The surface of one bed is entirely covered with obscure fucoids, weathering reddish, and standing out from the bed; while the surface of another bed weathers into large rounded and flattened concretionary forms	383	0
3. Similar alternations of thick-bedded grey limestone and thin irregular beds, with shaly divisions; the latter becoming more frequent towards the top. Some of the thicker beds are more or less arenaceous. The uppermost strata exhibit the peculiar weathering described at page 333, Report for 1873, which appears to be characteristic of these higher beds. The fossils are similar to those of No. 2	489	5
Total	972	8

Resting upon No. 3 of the above, are the shales and limestones of the Levis division with their characteristic fossils, a section of which has already been given in your Report for last year at page 337, as follows:—

SECTION No. 2.

	Feet.
1. Grey bituminous limestones, with partings of black or grey shales	4
2. Thin beds of bituminous limestone, alternating with black or dark grey shale, mostly shale at top, in which many fossils occur; *Lingula*, *Obolella*, some *Trilobites*, simple and compound *Graptolites*	6
3. Dark blue earthy bands of limestone, from 5 to 6 inches thick, with black or dark grey shales alternating in about equal proportion. Upper part filled with fossils, chiefly *Graptolites*	23
4. Black shales with numerous *Graptolites*	40
5. Dark grey calcareous sandstones, in beds of from 6 inches to a foot thick	20
6. Coarse grey brecciated limestone or conglomerate with calcareous sandstones again on top	30
Total	123

The last beds, No. 6 of the section, hold the coast northerly for a distance of 1 mile, dipping N. 60° W. < 27°. They then turn

into the land with a more northerly dip, and are succeeded by red, green, and black shales, with occasional beds of grey sandstone and thin bituminous and conglomerate limestones, all more or less disturbed by small faults, the shales at one place exhibiting most extraordinary contortions. The succession in ascending order from No. 6 of section No. 2 is as follows. The thicknesses are only approximate, and may be somewhat underestimated:—

SECTION No. 3.

Average dip N. 30° W. < 26°.

	Feet.	In.
1. Greenish-grey and drab shales, with a few thin shaly beds of grey sandstone interstratified near the top	164	1
2. Beds of greenish-grey fine-grained sandstone, from an inch to a foot or more in thickness, with shaly divisions at base. Some of the thin beds hold a few simple *Graptolites*	47	2
3. Loose, splintery, dark greenish shales having very black glossy surfaces, somewhat disturbed	50	0
4. Dark greenish, hard, cherty, nodular shales, with irregular splintery cleavage	70	0
5. Greenish-grey, red and blackish shales, often faulted, and otherwise disturbed in places; exhibiting similar blackened and polished surfaces to those of No 3. These shales are characterised by numerous nodules, and large masses of cubical iron pyrites	573	3
6. Greenish-grey rather coarse-grained sandstone	25	0
7. Red, green and blackish shales, with two or three beds of greenish-grey sandstone interstratified at nearly equal intervals; much confusion prevails amongst these shales caused by several small faults	400	0
8. Red and green slates, alternating in nearly equal proportions, considerably harder than any of the preceding shales. The cleavage is at right angles to the bedding, and they break into innumerable long, thin, sharp splinters. They are seen at first in a horizontal position, but become suddenly disturbed towards the top. (See Fig. 6, page 338, Report for 1873.) It is impossible to arrive at a conclusion regarding the thickness of these slates. It can, however, hardly be less than	150	0
9. Red, green and blackish shales, often finally laminated, with a few thin beds of bituminous limestone interstratified near the base, and some conglomerate limestone near the top; with a few thin beds of sandstone. (See Section at page 337, Report for 1873.) Several smaller faults occur here	230	0

	Feet.	In.
10. Fine and coarse grained greenish-grey sandstones and fine conglomerates, in beds of from 6 inches to a foot or more in thickness. The conglomerate beds are chiefly composed of fine quartz and grey limestone pebbles, with numerous angular grains of red feldspar, and occasional fragments of black shale, cemented together in a matrix of fine green sand. Some of the fine beds hold numerous spherical concretions of similar sandy material, but harder	300	5
11. Loose red, green, and dark brown shales, much broken and often concealed; not less than	500	0
12. Thin irregular beds of grey bituminous limestone, from 1 to 6 inches in thickness, with partings of dark brown and jet-black bituminous shale sometimes finally laminated. Iron pyrites thickly disseminated, and occurs occasionally in thin strata of 2 or 3 inches in thickness. Strata affected by a series of complicated folds. Thickness doubtful, but probably about	250	0
Total	2759	11

Following the shore northerly, a great gravel beach with low, flat, and often marshy country inland succeeds, and extends for a distance of over 7 miles to the mouth of Bennois Brook. There is no rock exposed in place on the shore in all this distance, except one small detached outcrop of grey sandstone near the middle of the sand-beach of "Three Guts Cove." The next coast exposure occurs on the north side of Bennois Brook, referred to and partially described at page 339, Report 1873.

Some parts of this exposure are amygdaloidal in character, the cavities being filled with green chlorite or white calc spar. Patches and strings of white calc spar, and some of white quartz, reticulate through the entire mass, which, when intersecting or associated with the dioritic and dolomitic rocks, very frequently contain native copper in small lumps and strings. In the quartz veins the metal was usually in thin films, while the green and blue carbonates stain all the rocks indifferently. The jet-like material referred to in last year's Report appears to be pure crystalline bitumen.

The whole or greater part of Fox Island is composed of trappean rocks, as described at page 340, Report 1873.

The coast exposures at the entrance of Bennois Brook, on the

north side, are brought in contact with a set of greenish and blackish shales by a fault which runs into the land nearly due east. These shales exhibit themselves in considerable disturbance near the contact, but farther north they are overlaid by strata of sandstone and shale in very regular succession, forming cliffs of from 40 to 50 feet in height, which extend to the southern point of Broad Cove near Bluff Head. Near the base of these sandstones there occurs a set of grey bituminous limestones and shales, supposed to be a repetition of No. 12, section No. 3; in which case it would appear that the succeeding beds of sandstone overlying are higher measures, which will give an additional volume of upwards of 1800 feet of thickness, making a total of 4621 feet.

The following is the measured section in ascending order, dip east, < 56°:—

SECTION No. 4.

	Feet.	In.
1. Greenish-grey sandstones, and red and green arenaceous shales, principally sandstones at base; sometimes coarse-grained approaching fine conglomerates, and holding pebbles of opaque white quartz, and red feldspar, in a green sandy matrix. Supposed equivalent in part of Nos. 10 and 11, section No. 3, about	400	0
2. Brown and black bituminous shales, with interstratified thin beds of grey bituminous limestone, much corrugated and faulted, say	300	0
3. Greenish-grey, fine-grained, slightly micaceous sandstones in thick beds, with occasional thin arenaceous shaly divisions; spherical concretions imbedded in the sandstone of the same material, but much harder than the general mass	234	6
4. Red and green arenaceous shales, with occasional interstratified thin beds of grey sandstone, and one or two thick beds of fine-grained red sandstone at the base ..	560	9
5. Coarse-grained grey sandstone, or fine conglomerates, with a few thin shaly divisions. The conglomerates are chiefly made up of worn quartz pebbles about the size of a swan shot, and grains of red feldspar, with occasional fragments of black shale in a matrix of fine green sand	330	0
6. Alternations of red and green arenaceous shales, with a few beds of grey sandstone interstratified. The shales at the base are generally green, the red occurring in the middle; while green and red alternate at the top	405	6

	Feet.	In.
7. Coarse and fine grained sandstones, or sandstones and conglomerates in thick beds, with a few thin shaly divisions. The general character of these sandstones corresponds very nearly with those of No. 5 of this section	330	7
Total..	2561	4

From No. 3 to No. 7 of this section, the description corresponds with No. 16 of section given at the coast near Hawkes Bay and southern arm of Bonne Bay.*

A gravel beach conceals the rocks for about a mile within Broad Cove, but at the northern point a great mass of trap breccia of similar character to that of Fox Island comes in, running in the direction of Bluff Head. On the north side of this trappean mass, a portion of the sandstones and shales already mentioned is repeated in very disturbed strata, forming a small wedge-like trough, which occupies about half a mile of the shore. At page 340, Report for 1873, it will be seen that a fault is suggested as occurring at the immediate junction of the latter sandstones with the rocks of Bluff Head. The run of this dislocation is about due east, and on this course between the sandstones and the serpentine rocks of Bluff Head, a large mass of brecciated trap is interposed, which in some cases was found intercalated with the latter, all of which are much altered and in great confusion.

At Bluff Head the rocks consist of dark grey diorites, purplish limestones or dolomites, and dark green chloritic and slaty serpentine, confusedly jumbled up with trap, breccia, and greenstone.† At the outlet of Bluff Head Brook, just north of the Head, a purplish-coloured dolomite or limestone of a brecciated structure rests upon sandstone, which is itself underlaid by bituminous limestones and shales, representing the beds of No. 2 of section No. 4 south of Broad Cove. These strata of sandstones, &c., come to the surface on the axis of a small sharp anticlinal fold, the mere apex of which is exhibited peeping out from below the dolomite.

The lowest member of the magnesian group here is, as before

* See pp. 291-293, 'Geology of Canada,' 1863.

† Malaphyres are frequent.

stated, a brecciated dolomite or limestone, the breccia consisting of angular fragments of various sizes, cemented together in a purplish calcareo-magnesian paste, through which green chlorite runs in irregular and manifold strings and patches, while veins or thin reticulations of white calc spar ramify in all directions, giving the rock a marbled or mottled appearance. These veins of calc spar, like those of the Bennois Brook section, frequently contain nests or strings of jet-black crystalline bitumen, and native copper occurs in irregular shaped lumps. The green and blue carbonates of copper were observed to stain alike the calc spar, the crystalline bitumen, and the purple dolomite. The thickness of this mass does not seem to exceed 50 or 60 feet. The succeeding rock overlying the dolomite is a confused mass of chlorite slate, diorite, and serpentine, the disturbance apparently being caused by the intrusion of a diorite dyke, which intersects all the strata. The serpentine portions are intersected by thin seams or veins of asbestos, and the rock frequently assumes the character of picrolite. The general colour of the serpentine is a dark bottle-green, weathering a brownish red or occasionally a deep Prussian blue. Diorites succeed this serpentine, approaching Lewis Brook in great mass, occupying the shore for nearly a mile. The prevailing character is dark grey, fine grained, hard and compact, sometimes slightly calcareous, with small cubical crystals of iron pyrites profusely disseminated. Occasionally these rocks are perforated by cylindrical or elliptical shaped tubes filled with crystalline calc spar, the weathered surfaces of which resemble an amygdaloid. It is also sometimes porphyritic, having small rounded masses of vitreous white quartz irregularly distributed.

The latter rocks are overlaid by green chloritic slate and impure slaty serpentine, with one band of moderately pure serpentine about 20 feet thick near the base, and a band of light green chlorite about 10 feet thick at the top, the whole mass being nothing under 150 feet in thickness.* Resting on the chloritic band is an immense mass of purplish-red dolomite of slaty structure. This rock, like the lower dolomite already described, is intersected by veins of white calc spar, with which

* See pp. 341 and 342, Report for 1873.

native copper is sometimes associated. The dolomites cap the cliffs at Lewis Brook and the hill range inland, with occasional interruptions of the subordinate rocks, which are brought up upon faults and in folds of the stratification. The actual thickness of the whole of this great magnesian group is very difficult, if possible, to determine, but would appear to be certainly not less than 1500 feet.

On Lewis Brook, about 500 or 600 yards from the outlet, some strata of sandstone of exactly similar character to that seen on the south side of Bluff Head passes below the dolomites last mentioned, dipping to the eastward. These sandstones then crop out on the sea-shore, about 20 chains north from the outlet of Lewis Brook, dipping generally S. 75° E. $<$ 36°, and continue to strike along the shore, displayed in cliffs of between 20 and 30 feet high, towards the outlet of Serpentine River. This dip points towards the base of the Serpentine range, and at short distances up the small brooks the junction is visible, where in all cases the serpentine was found to rest upon the sandstones. The exposures here are clearly a repetition of the section No. 4, and include the bituminous limestones near the base of the same, the thickness and order of succession being almost identical.

At Rope Cove Head, about 2 miles south of Serpentine River, the stratification is interrupted by the intrusion of a mass of trap of peculiar character. It is nearly black, and much of it is soft, earthy, and calcareous, reticulated with veins of calc and bitter spar, with crystalline bitumen in the cracks and interstices enclosed in spar. Portions of this dyke are breccious. On the north side of the dyke, greenish, dark brown, and blackish shales, with interstratified thin beds of grey bituminous limestone, are brought to the surface, which appear evidently to be another repetition of the limestones near the base of section No. 4. These limestones and shales form cliffs of 50 or 60 feet in height, exhibiting the most wonderful and complicated contortions, disturbances apparently in a great degree peculiar to these rocks, the associated strata above and below being comparatively only slightly displaced. At this place the said disturbances appeared to have reached a climax. The folds and repetitions are so numerous that within a distance of 2 miles of the coast the total thickness of

the whole mass composing the cliffs does not much exceed 350 or 400 feet.

A great mass of trap comes in at the mouth of Serpentine River, which forms low bold cliffs on both sides of the stream for a few hundred yards up its course. The great headland on the north side of the cove at the entrance to the river is composed of a brecciated trap rock, and at the head of the cove a patch of the stratification, consisting of black and green shales, is caught up and wedged in between two masses of the igneous rock; while a remarkable isolated bed of sandstone of triangular shape, about 10 or 12 feet thick, with a base of about 50 feet, rises perpendicularly from the water's edge to the height of about 100 feet, terminating in a small flattened apex, upon which a tuft of grass still grows.

The coast-line north of Serpentine River has still to be examined, but the bold and broken outline of the hills and headlands, of which Bear Head is the most prominent, seem to indicate the probability that the rocks are, for the most part at least, of igneous origin, and a continuation of the traps of Serpentine River.

The banks and islands at the lower part of Bennois Brook consist of low flat land in which no rock is exposed, but at about 100 chains up from the outlet, following the course of the river, a bed of coarse-grained grey sandstone strikes across, dipping N. 37° W. $< 70°$. A little higher up the stream the banks display more sandstones, underlaid by dark greenish shales in a nearly vertical attitude, and these shales continue to crop out at irregular intervals, sometimes forming high and broken cliffs. They are often filled with nodules and masses of iron pyrites, and have frequently the smooth, black, glistening surfaces which characterise the rocks of Nos. 3 and 5 of section No. 3 of the coast. Interstratified with these shales are some peculiar beds of conglomerate limestone, some of which are composed of rounded boulders of grey limestone upwards of a foot in diameter, and also partially worn fragments of thin-bedded limestone of an elongated or elliptical form, cemented in a base of dark green or blackish shale. The larger and more rounded boulders appear to be the ruins of the Calciferous rocks, while the thinner fragments are probably derived

from the beds near the base of the Levis shales. A little higher up the stream, a lower bed occurs of a brecciated limestone, the matrix being of a hard, compact, pale grey shade, holding angular fragments of limestone of a darker colour, and innumerable pieces of black slate. All these rocks are much corrugated, and repeated by dislocations. They continue to be seen occasionally for between 4 and 5 miles farther up the stream, and then the strata roll over in an anticlinal form and dip about east. The next rocks in succession seen are some strong beds of sandstone overlaid by red and green shales, which are succeeded by some thin-bedded, dark grey, bituminous limestones, with partings of dark brown and black bituminous shales, rising in cliffs of about 150 feet high on both sides of the river, all folded, twisted, and corrugated in a high degree. Numerous simple *Graptolites* occur in the shales, and are also observable on the surfaces of the limestones. The exposures here are supposed to represent No. 12 of the section No. 3 on the coast. The limestone beds vary in thickness from 1 to 18 inches, and the shaly divisions are sometimes mere partings, while at other times there is an accumulation of 1 foot or over. The darker coloured shales are very bituminous, and burn with a bright clear flame when exposed to a strong heat for a lengthened time, but without producing any ash, although much gas is evolved. Resting against these, and apparently above, are bright red and green shales, in which the stratification gets more regular, and at a turn of the river, about 15 chains higher up, they strike across it, showing a dip of N. 54° E. $<$ 32°. Ascending the stream, the exposures get fewer, but grey sandstones and greenish shales are occasionally exhibited on the banks and bed, which, although not well exposed, probably spread over the whole breadth of about 2 miles, lying on the axis of a synclinal line. At about 2¼ miles from the same place, or about 3 miles below the first forks of the river, some strata of coarse greenish-grey sandstone strike across, running S. 20° W., N. 20° E., exhibiting a high dip to the westward. These bands of sandstone were taken to represent the upper part of the coast section No. 4. A mile and a half up the stream from the last exposure a mass of trap comes in, giving a precipitous face to the left bank, and running S. 14° W. Beyond this the river widens, and the rocks are nowhere exhibited for about 2 miles, or 1 mile above

the forks, when a small section of sandstone comes to the surface, and a little above, another exposure, consisting of limestone conglomerate and green shales, dipping N. 76° E., at a moderate angle. About 25 chains above the last, the bituminous limestones and shales reappear in a cliff between 20 and 30 feet high, exhibiting the usual corrugations and folds. Nothing is seen for the next half mile, but at that point the grey, strong-bedded limestones of the Calciferous formation rise in mountain masses upon either side, the river flowing in a deep gorge between. On the west side of the river the Calciferous strata strike in a vertical attitude, N. 25° E., while immediately north and west from the latter a high, bare, brown-weathering mountain range is seen, indicating the presence of the Serpentine group.

It has already been stated that the rock at the entrance to Serpentine River consists of a great mass of trap, which continues up the stream for between 300 and 400 yards. Associated with this trap, and in some instances caught up in it, are patches of the stratification, consisting of dark green and black shales, and at one place a bed of conglomerate limestone interstratified with the shale comes against the trap, evidently disturbed by it. These rocks represent divisions 8 and 9 of section No. 3. Similar shales present themselves at the mouth of the tributary on the south side, about a mile up the stream. For a distance of 6 miles on the ascent of the river, exposures of the rock are rare, but at the end of 2 miles an altered sandstone or quartzite was seen crossing the stream, dipping at a high angle S. 22° W., and sandstones and shales come up at intervals in low anticlinal folds for the remaining distance, the sandstones at the end which form a fall, dipping S. 9° E. < 23°. A second fall occurs over similar sandstones about 20 chains above the first, which were supposed to be on the horizon of the upper part of the coast section, No. 4, south of Broad Cove. Above this no rock is seen below Serpentine Lake. Sandstones and shales come out on the north shore of the lake, in a few small rather obscure sections; but the bare brown-weathering flanks of the Blomidon Serpentine range rise abruptly a short distance back, reaching an altitude probably upwards of 2000 feet. On the opposite or southern shore of the lake the limestones of the Calciferous rise precipitously into mountain masses, averaging a height of not less than 1000 feet above the level of the sea, ranging towards the

head waters of Bennois Brook. Within a mile from the outlet of the lake, and a little westward from the Calciferous mountains, a deep ravine runs S. 38° W., the western side of which is bounded by the Serpentine range of the Lewis hills.

In their western extension the Calciferous and Potsdam formations strike into the peninsula of Port-a-Port, holding the north coast of St. George's Bay for the entire distance from the Gravels to Cape St. George. The strata exposed in the coast section display a succession of parallel dislocations running in a nearly north and south direction, bringing distinctively different beds into juxtaposition. The upper part of the Calciferous (the peculiarities of some beds of which were described in last year's Report, page 333), keeps the shore of East Bay, with some interruptions at the coves, where Lower Carboniferous rocks are let down, as shown at page 334, Report 1873, for about 3 miles, thence striking south-westerly with a north-westerly dip, is succeeded by the graptolitic shales at the base of the Levis division. A patch of the unconformable Lower Carboniferous series conceals the older strata in a great measure at this place, except where a slight undulation of the latter with their typical fossils brings them out from below the former at the base of the bank. Westward from this Carboniferous patch, the strata, representing section No. 3, occupy the remainder of the head of East Bay, and the whole of Shoal Point, various members of the group coming up at intervals along the shores. On the western side of Shoal Point, near Piccadilly, some red and green slaty bands, supposed to represent No. 8 of the same section, strike into the land with a north-easterly dip, showing the existence of a trough, in which Shoal Point lies nearly on the axis. Near the extreme point the bituminous limestones and shales of the top of section No. 3, or near the base of section No. 4, exhibit themselves at low water on both sides, standing in a vertical attitude, and striking about N. 20° E., S. 20° W. These bituminous limestones are characterised by the presence of a set of drusy cavities lined with crystals of calc spar, which are often filled with petroleum in a semi-liquid state of about the consistency of tar. On the west side of the Point this substance exudes through the sand, and at low water is sometimes found in small depressions, where it has frequently been gathered by visitors. On the west side of Piccadilly a fault occurs running a little obliquely to the strike of the rocks

S. 30° W., which brings up the Calciferous limestones in a small anticlinal fold, with the shales of the Levis division resting on them, which dip N. 24° W. $<$ 28°, and holding numerous *Graptolites.* Another fault parallel to the last mentioned, and only about 300 yards farther on, strikes up the course of a small stream, bringing the graptolitic shales to a vertical position, which are succeeded by a mass of coarse grey brecciated limestone in a series of sharp folds, and forms the projecting point on the west side of Piccadilly. The graptolitic shales again come out on the shores of West Bay about a mile west from the Point in a fold of the stratification, where many small *Lingulæ* were found in association with the *Graptolites.* Overlying the latter are a set of green, red, and blackish shales, in low detached cliffs along the shores of West Bay, the measures spreading out inland over a large area. At Black Head, where the bay curves north-eastward to form Long Point, sandstones and shales strikingly resembling the upper parts of section No. 4 are exposed in high bold cliffs of vertical strata, for nearly half a mile, coming somewhat obliquely to the shore. The total thickness here is 1879 feet. The lithological resemblance between the rocks of this section and those previously described of the eastern side of the bay, leaves little doubt that they are on the same horizon. They are of the same greenish-grey colour, are composed chiefly of fine green sand with coarser bands composed of grains of white quartz and reddish feldspar, and occasional fragments of black shale; while some of the finer-grained beds hold spherical-shaped concretions of a similar material to the general mass, somewhat hardened, of various sizes, and generally arranged in layers parallel with the stratification. The above section of sandstone terminates abruptly against a great fault running N. 54° W., on the north side of which some beds of a hard compact grey limestone are brought in, in a nearly vertical attitude, striking N. 78° W. obliquely to the dislocation. Over these limestones are a set of greenish and dark brown, soft, thinly laminated shales dipping first at a pretty high angle, but farther on assuming a smaller incline N. 20° W. $<$ 44°. Near the top of these shales they become interstratified with thin beds of bituminous limestone, from 1 to 6 inches in thickness. The surfaces of the latter shales are frequently covered with fine pencillings of fossils, all of the graptolitic type, but chiefly of species resembling *Callograptus*,

Dictyonema, or *Dendrograptus*. The dip of these rocks decreases advancing along the shore, inclining still in the same direction, and 20 chains from the fault, they are overlaid by beds of grey very calcareous sandstone from 6 inches to 1 foot thick, having an even cleavage parallel to the planes of the bedding. No fossils were found in the sandstones. They occupy about 40 chains along the shore on the strike, making a few gentle undulations, until coming in contact with a trap dyke about 6 yards wide, which cuts them off, running N. 9° E. On the west side of the dyke the shales are slightly brushed up, while on the east side higher measures are brought down pointing towards it. These higher rocks consist of bluish-grey limestones, in beds from a few inches to 2 feet thick, divided by greenish argillo-arenaceous shale. Many of the limestone beds weather of a pale yellowish drab colour, and are apparently slightly magnesian. The dip near the dyke is S. 79° W. < 49°, but a little farther on easterly, they roll over and dip N. 27° E. < 23°. Farther east the strata bend round and show a dip N. 56° W. < 22°, and towards the extreme of Long Point the dip is N. 15° W. < 23°. The limestone beds are constituted almost wholly of organic remains, crowded with *Encrinites* mostly fragmentary, together with numerous corals, *Orthoceratites*, univalve and bivalve shells. The lower beds are sometimes almost entirely made up of spherical-shaped *corals* (?)* standing out in relief from the surfaces, at a distance of a foot or more apart, giving the rock a coarse concretionary aspect. Rising on the strata these spherical forms become less numerous, but abundant and well-preserved organisms continue throughout. This fauna has already been referred to Mr. Billings for identification, who has no hesitation in declaring it to be typical of an age, nothing older than the Birdseye and Black River groups of New York and Canada, and consequently the highest member of the Lower Silurian system yet recognised in Newfoundland.†

On the north-west side of Long Point, facing the Gulf of St. Lawrence, higher measures are exposed dipping N. 15° W. < 18°,

* See Report 1873, p. 342.

† Some *Graptolites* found on the upper falls of the Exploits River, and a few fossils at certain parts of Notre Dame Bay, appear to be of Hudson River group types. Organic remains are also known in some neighbouring localities, characteristic of the middle Silurian age; but the precise horizon of the former fossils still requires confirmation.

which consist of beds of greenish-grey, compact arenaceous limestones, with thin divisions of arenaceous shale. Some of these strata are flaggy, and very evenly bedded in layers of 2 or 3 inches in thickness. The surfaces of the flags are often covered with fucoidal remains, and on one bed a series of deep grooves, some upwards of 2 inches in width, were seen, sometimes running for several yards in a moderately straight line, at others in a zigzag course and occasionally in a curve, intersecting and crossing each other in all directions. The uppermost beds of all, only visible at low tides, are thin-bedded limestones crowded with *Brachiopoda*, chiefly of the genera *Orthis*, *Leptæna*, and *Strophomena*. The total thickness of this Long Point group of strata, although not positively ascertained, would appear by the dips upon each side and the breadth of the peninsula to be about 800 feet.

At a place called Shoal Cove, about 8 miles from the extreme end of Long Point, on the gulf side, rocks of the Lower Carboniferous horizon form a narrow strip along the shore south-westwards to a place called Three Rock Point, where they run out into the sea. These strata consist of red micaceous sandstones and conglomerates, with a few thin beds of limestone which contain Carboniferous fossils. Farther south the basic conglomerate comes in on Red Island, as shown in your Report for 1866, while the fossils of the Carboniferous limestone were recognised at a point nearly opposite on the mainland, close to a fault, where the unconformable strata are brought into abrupt contact with the Silurian.

About 3 miles inland from West Bay, on the banks of the streams, coarse conglomerates were found overlaid by fine-grained micaceous sandstones in a nearly horizontal attitude, which may belong to the base of the Lower Carboniferous, equivalents of the conglomerates of division *a* of last year's section, page 310. From the flat character of the country surrounding these exposures, it was inferred that they spread over an extended area, although the slight incline they show to the horizon would be unlikely to bring in any of the succeeding higher members of the formation.

General Structure—East Side of Port-a-Port Bay.

The facts ascertained, as already represented in the description of the coast and river sections on the east side of Port-a-Port Bay,

seem to point to the conclusion that the Silurian formations are arranged in a series of sharp anticlinal and synclinal folds, ranging generally about N. 22° E., S. 22° W.; the whole mass of strata having, towards the close of the later deposits or subsequently, been affected by vast igneous intrusion, and become much dislocated by a set of great parallel or nearly parallel faults, the general trend of which is north-east and south-west. At the summit of the whole series is a great volume of igneous and magnesian rock, consisting of various diorites, serpentines, and chlorites, which our evidences seem to indicate to be lapped over the inferior strata unconformably, and to come in contact with different members at different places.

In former Reports allusion has been made to the presence of calcareous strata of Potsdam and Calciferous age, as coming into direct contact with Laurentian gneiss at the head waters of the two Spruce brooks; that is, the stream which falls into the Grand Pond on the one hand, and into Harry's Brook on the other. These rocks, in their northern strike, cross to the eastward of St. George's Pond (of Harry's Brook), and thence on to the Humber River, where it enters the arm; and southerly they point for the main gut of St. George's Bay, where they pass unconformably below the coal measures.

The axis of the main anticlinal appears to run nearly on a line between the outlet of Rivière Blanche and the head of Serpentine Lake, the southern projection of which points straight down the Bay St. George in the direction of the Magdalen Islands. At the coast between Indian Head and the Gravels the Silurian strata are mostly concealed below the unconformable coal measures, but beyond and north of the Carboniferous patch the calcareous lower rocks rise in a mountain range, and are probably wrapped over a nucleus of Upper Laurentian, connected with the labradorites of Indian Head. From this central anticlinal a set of parallel wave-like undulations extend on either side, which, to the eastward, finally terminate against the Laurentian hills of the interior; and to the westward are recognisable towards the coast of Port-a-Port Bay, in the repetition of the higher formations. The Gravels section of Potsdam and Calciferous strikes into the mainland in a lofty mountain chain, bearing generally nearly north-east (but making several curves in its course) towards Serpentine Lake, at

which lake the rocks forming the range roll over, dipping easterly, and the eastern flanks of the hills strike for the mountains on the west side of St. George's Pond; the latter and the valley of Harry's Brook lying on the axis of a trough. On the west side of the central anticlinal, between the mountain range and the coast of Port-a-Port, there appear to be two anticlinal and two synclinal lines, with many subordinate folds within; the axis of the former keeping the Levis formation to the surface; while the troughs are occupied by the great mass of sandstone and shale of section No. 4. The disturbed condition of the strata on the upper reaches of Bennois Brook distinctly indicates the existence of a great fault running through the country in the direction of Serpentine Lake; and at about 2 miles above the forks, the break in the Calciferous mountains which there cross the river, shows a displacement of upwards of 1000 feet, with a downthrow on the north-west side. At this place the calcareous range comes in close proximity to the serpentines of the Lewis hills on the north-west side of the fault, which is suggestive of the want of conformity and overlapping of the latter formation.

The junction of the strata of section No. 4 with the serpentines, is obscured at Bluff Head by the presence of a great mass of trap, where also the igneous rock is intercalated with the ophiolites; but farther to the northward the sandstone group was invariably seen to pass below the serpentines, which were wrapped over the former in a confused and irregular mass, the points of contact differing at different parts in such a manner as could only be accounted for by supposing the ophiolites to be unconformably related. In your notes for 1866, similar relations are recorded as having been observed in the Bay of Islands, where the sandstones of Harbour Island and the mainland opposite were seen to pass below the serpentines of the Blomidon mountains; and they also seem to be in accordance with the description given of the rocks of Bonne Bay, by James Richardson, of the Geological Survey of Canada, in 1862.*

In the peninsula of Port-a-Port, or third area, the axis of an anticlinal is indicated at Piccadilly, where the Calciferous comes out sharply, with the succeeding Levis formation flanking it on

* See 'Geology of Canada,' p. 293.

either side. The upper members of the latter formation have already been shown to occupy Shoal Point and a large extent of country on the mainland at West Bay, having at their summit a vast mass of sandstone corresponding with the sandstones of No. 4 section, which are abruptly brought against a set of very fossiliferous limestones by a fault. These limestones appear by their organic contents to be about the horizon of the Birdseye and Black River or Trenton groups. The metamorphic rocks, so largely displayed on the east side of the bay, however, are apparently wanting, or at all events have not as yet been seen; and a question arises whether their horizon is above or below the aforesaid limestones. Possibly this problem might be solved by a careful stratigraphical survey of the south-west end of the peninsula, which still requires more minute investigation.

A great centre of volcanic action is indicated along a line north of Fox Island, and on the coast to the South Head of the Bay of Islands, from which dykes radiate in almost every direction; while the scoriaceous, breccious, and amygdaloidal sheets which are found interstratified or intercalated with the ophiolites, may be the result of outpourings of lava from volcanoes, and of contemporaneous origin; but whatever age these intrusions may eventually prove to be, they are evidently Pre-Carboniferous, as while dykes have been found to intersect all the lower strata, as shown in the details already related, they were in no case found to extend into the Carboniferous series, although in several instances their courses pointed directly in the direction in which the various patches are situated.

The following is a list of the principal intrusions and masses of trap that were observed, giving the geographical position and the courses.

No.	Character.	Width, &c.	Locality.	Direction.
1	Dyke	18 feet	Near Black Head, West Bay ..	Run N. 10° E., S. 10° W.
2	Dyke and fault .	6 „ (?) ..	W. side Piccadilly	Run S. 30° W., N. 30° E.
3	Dyke	12 „	Head of East Bay	Run S. 35° W., N. 35° E.
4	Trap and breccia	The whole island	Fox Island ..	Trending N.E. and S.W.
5	Trap, breccia, and chlorites, &c. .	Extending 1 mile along shore ..	Mouth of Bennois Brook	General run N. 75° E.

No.	Character.	Width, &c.	Locality.	Direction.
6	Great mass greenstone, breccia, &c.	.. ..	Bluff Head ..	Strike E. and W.
7	Dyke of diorite .	100 feet	1 mile N. of Bluff Head Brook ..	Run E. and W.
8	Dyke of greenstone	Width unknown	1 mile below the forks of Bennois Brook	Run S. 18° W., N. 18° E.
9	Dyke of greenstone and breccia	700 feet	Rope Cove Head	Run N. 60° E., S. 60° W.
10	Trap, breccia, &c.	A belt upwards of 2 miles wide	From mouth of Serpentine River towards South Head, Bay of Islands	Run N.E. and S.W.

FAULTS.

1. Bringing down the fossiliferous limestones of Long Point against the sandstones of Black Head. West Bay, Port-a-Port, runs N. 54° W., S. 54° E.
2. Two parallel faults on west side Piccadilly, run S. 30° W., N. 30° E.
3. At Small Cove, 1½ mile north of the Gravels, east side Port-a-Port Bay, runs S. 54° E., N. 54° W.
4. Two parallel faults about 14 chains apart, one at the base of the corrugated shales, and the other at the sandstone Bluff, about 3½ miles north of the Gravels, run N. 75° E., S. 75° W.
5. Great fault of Bennois Brook, N. 30° E., S. 30° W.
6. On mainland opposite Fox Island, E. and W.

CARBONIFEROUS FORMATION.

At page 333 of last year's Report, an account is given of the manner in which members of this group became entangled with and let down among the Silurian strata at the coves in the East Bay west from the Gravels. These, with some small additional patches of the lower measures occupying limited areas of the peninsula, are all that a great denudation has left of the formation to indicate that it must at one time have spread far and wide over a great space, and probably far beyond its limits now covered by the sea. The rocks composing the sections at the coves consist of pale cream-coloured limestones, fine-grained greenish-grey and reddish micaceous sandstones, and red and green marls. The

limestones are frequently filled with beautifully preserved fossil shells, from which large collections have been made at different times, and are now deposited among the collections at this place. For a description and identification of these fossils, the Survey is indebted to the kindness of Mr. T. B. Lloyd, who, while employed exploring for the Newfoundland Land Company, made a collection of the various species found in this locality, which were eventually referred to the eminent palæontologist, Thomas Davidson, Esq., F.R.S., on whose authority the following list is given:—***Spirifera glabra, Rhynchonella pleurodon, Streptorhynchus crenistoria***, var. ***senilis; Productus undatus, Productus semireticulatus***, var. ***Martini, Terebratula sacculus*** or ***hastata***, and a variety of other fossils. We are further indebted to Mr. Lloyd for permission to quote some remarks made upon these fossils by Mr. Davidson, which are extremely interesting, as showing the close analogy which existed contemporaneously in organic life upon what are now the nearest extremities of Europe and America:—"The Carboniferous limestone of Newfoundland appears to be exceedingly fossiliferous, and to entirely agree with a similar rock found in Yorkshire and elsewhere. The species of *Brachiopoda* it contains, judging from the species sent, are few in numbers, but very abundant in specimens. They are all well-known British forms, and will be found described and figured in my great work on British fossil *Brachiopoda*."

The position of these fossiliferous beds in these exposures appears to be near the base, and they are associated with a confused mass of shale and marl, in which some thin layers of carbonaceous material or impure coal can be traced occasionally, making zigzag lines in the face of the cliffs, which indicate the corrugations. Nodules and small strings of snowy gypsum, together with irregularly formed masses and balls of iron pyrites (probably mispickel), are frequently met with, while the cracks or fissures are usually filled with a red or yellowish ochreous clay. Carbonised and comminuted remains of plants are seen scattered over the surfaces of the sandstones, occasionally aggregated in nests or patches of coal.

The coves west from the Gravels, in which the Carboniferous strata are let down among the Lower Silurian rocks, are six in number, the fifth of which, called Jack of Clubs' Cove (from the occurrence of a remarkable figure there displayed by the peculiar

wearing of the beds of Silurian limestone), is 3 miles distant. The sixth and last is half a mile farther west, and the Carboniferous measures there seem squeezed up, as in a narrow fissure between two walls of Lower Silurian strata, the latter dipping on either side, with a moderate and perfectly regular angle to the north. Half a mile west from the last cove, Carboniferous strata are met with, consisting of limestone and marls with gypsum, which rest unconformably upon the basset edges of the Calciferous and Levis rocks. Among the beds of the latter there is a dark grey calcareo-arenaceous band, which weathers yellowish, the smooth surfaces of which are often sprinkled over with a large *Lingula*, the dark colour of the shells contrasting strongly with the light shade of the weathered rock; and on the same surfaces some very perfect small *Trilobites* occur, which appear to be allied to the genus *Ampyx*. The *Lingula* strongly resemble *Lingula nympha*. *Palæozoic fossils*, page 214.

At the junction of the older and newer formations, the mineral spring mentioned at page 346, Report 1873, issues. The Carboniferous patch here occupies about a mile of the shore, and probably extends about an equal distance inland, or possibly farther, over the level tract which there is of considerable area. A little distance westward from the spring some small masses of gypsum protrude through a beach of marly clay. On the western side of this patch some fine-grained, greenish-grey, finely micaceous sandstones come out, the surfaces of which are speckled with obscure carbonised remains of plants, supported upon a very coarse loosely aggregated conglomerate, chiefly made up of boulders and pebbles, derived from the Calciferous formation. The occurrence of another patch of Lower Carboniferous has already been indicated as being spread over an extensive tract a few miles into the interior of the peninsula, back from the shores of West Bay,* and another has also been shown to exist as skirting the outer coast of Long Point.

The rocks between Crabb's and River Brooks are principally red and green slightly micaceous sandstones, marls, and limestones, members of division *c* of last year's section. The dip of these

* Too little of these sandstones are exposed for identification without fossils. It is not at all improbable they may prove to be a continuation of the sandstones seen on the shores of West Bay.

rocks is N. 49° W. < 46°. Beyond River Brook there are no exposures for about 4 miles, the cliffs facing the bay being of superficial drift; but at that distance a great mass of gypsum comes out, underlaid by red and green sandstone and marls. Farther south-west similar masses of gypsum and associated rocks are repeated several times in the distance of 2 miles, and at one place within the last half mile, an enormous mass of limestone about 20 feet thick, almost entirely composed of fossil shells of one species, *Terebratula sacculus* (?), stands up vertically from amongst red marls, with huge cliffs of gypsum rising on either side. Some beautiful examples of crystalline gypsum, or selenite, were found in these gypseous cliffs, sometimes running in veins, and at others in patches. Coming up from below all the above strata are sandstones corresponding with the top of division *a*, which rise in nearly a vertical attitude, forming high and precipitous cliffs, striking in the direction of Cape Anguille.

The rocks at the entrance to Crabb's Brook will be found described at page 317 (last year's Report); but on ascending the stream there are no exposures, until getting about 3½ miles up its course, when some bright red marls, red sandstones, and fine reddish conglomerates were seen dipping S. 65° W. < 36° A little farther up, where the river makes an easterly bend, a bed of grey rough nodular limestone comes to the surface with a corresponding dip, and therefore seemingly passes below the former exposure, in which, however, no fossils were detected. These seem to belong to the upper part of division *c*. Higher up the stream no exposures are seen for another mile, the first beds that crop out being fine-grained, thin-bedded, grey micaceous sandstones, interstratified with black and dark grey carbonaceous and finely micaceous shales. In the shale numerous *Stigmaria* rootlets and beautiful impressions of ferns, some supposed to resemble *Odontopteris*, were found. The sandstones contain carbonised impressions of plants. These beds are succeeded above by rather coarse-grained light reddish sandstones holding numerous fossil trees and some impressions apparently of *Sigillaria*, together with many small nests and strings of coal. The whole is overlaid by thin beds of fine-grained red sandstone and shale, and the total thickness of the exposure seems scarcely to exceed 100 feet. The fossil and mineral character of these last-named beds seem to place

them about the horizon of the upper part of division *d* or lower part of *e*. Although the section exposed to view at this place is limited, there is room to bring in higher measures between it and the middle Barachois Brook, which is distant a little over 3 miles; and as it is with these divisions that workable seams of coal may reasonably be looked for, should experimental boring be adopted, that portion of the country is well worthy of a fair trial.*

The next rocks exposed up the course of the stream, and about 20 chains distant from the end of the last section, are red and green marls with gypsum, in all respects resembling division *b*, beyond which there is an interval of about a mile blank of any exposures, and then another exhibition of marls and gypsum, underlaid by red and grey sandstones with coarse reddish conglomerate, dipping N. 75° W. < 31°. These latter, which correspond with division *a*, then occupy the banks for 3 miles higher up the stream, exhibiting gently undulating or horizontal strata, the gypsum and marls coming in for the third time at the end of that distance, which are succeeded farther up by the lower rocks of division *a* showing themselves occasionally for a few miles farther. On the upper reaches no exposures whatever are met with until approaching the gorge in the Long Range mountains, where cliffs of hornblendic gneiss cross the river, dipping N. 79° E. < 60°.

The Cape Anguille mountains display very little rock in place except in the gorges of the brooks on either side, their flanks being covered with forest, bush or marsh, and the summits by dwarfed trees, or grass and loose débris. The sections on the brooks in each case bear the characteristics of division *a*, while the loose rocks scattered over the surface at the higher elevations seemed, with the exception of a few boulders of gneiss, to be derived from the same source. At one place, nearly midway between the coast and the Codroy River, in the bed of a brook called Folly's or False Gulch, a few beds of red and grey sandstones crop up, which were supposed to belong to the same division.

* At first sight these upper rocks of *e* were supposed to be brought down against those of *c* by a fault, but there appears to be some reason to suspect that the relation here is rather due to some slight want of conformity; and if so, the Newfoundland series will still further accord with the distribution in Cape Breton, where the officers of the Geological Survey have lately begun to consider the Millstone Grit as being deposited unconformably on the Carboniferous limestone.

The evidences so far as ascertained seem to lead to the conclusion that the whole or greater part of the Cape Anguille range of hills are of Lower Carboniferous age, consisting in the main of the division *a* which is folded over in an anticlinal form, bringing in the succeeding divisions *b* and *c* on the flanks, as exhibited on the coast of St. George's Bay on the one hand, and on the Great Codroy River on the other. The nature of the nucleus of this great fold is still undetermined, and the unconformable relation of the series to all the older formations renders suggestion of probabilities purely speculative; but it is possible that some information may be gathered upon this point by a careful study and survey of the cliffs between the Highlands and Cape Anguille, which has not yet been accomplished. Judging from the attitude the rocks, where seen, are found to assume, it is possible that within the nine miles traverse of the anticlinal there may be several minor folds or wrinkles repeating the same strata again and again; but we have hitherto failed to find an instance of protrusion of an older rock, or intrusion of a newer or igneous one.*

In your Report of last year, at page 315, attention is called to the disturbed state displayed in the strata in all cases near the gypseous outcrops, and a suggestion is there made that the movements may, with great probability, be attributed to an expansion having taken place in the conversion of an original anhydrite into gypsum by the absorption of water. In every case where this mineral was observed during the late season, the same phenomenon occurs, a notable instance of which is in one of the coast exposures at the Highlands, where the great mass of fossiliferous and unaltered limestone is brought into a vertical attitude between two great masses of gypsum seemingly within a sharp fold. This is an example on a large scale similar to that represented in your Report for 1866, at page 87, near Codroy.†

It is unnecessary to enter into detail respecting the strata

* The absence of rocks of igneous origin in the Carboniferous series of Newfoundland is the more remarkable, as it would appear that in Nova Scotia there are evidences of active volcanic operation during that period, and especially towards its close.

† For instructive information on natural chemical reactions, a perusal of a pamphlet entitled "Some Reactions of the Salts of Lime and Magnesia, and Formation of Gypsum and Magnesian Rocks," published by Dr. Sterry Hunt, F.R.S., in the 'American Journal of Science and Art,' vol. xxviii., 1859, will be found invaluable.

exhibited on the banks of the Great Codroy River, as a full description has already been given of that country in your Report for 1866–67, and a detailed section will be found in the Appendix to the Report for 1868, a map of which on a scale of 1 inch to 1 mile is now deposited in this office. It will be seen by reference to these Reports and map, that the upper Carboniferous measures, the equivalents of *d* and *e*, keep the whole coast between the mouths of the Great and Little Codroys, with a moderately regular dip nearly all the way, pointing towards the Laurentian mountains. The great fault described in Report for 1866, probably runs out at or very near the outlet of the Little Codroy; where, however, the strata are concealed under a great accumulation of sand; and no rock is seen in place following the coast thence southerly until reaching Trainvain Brook, where the lower Carboniferous conglomerate and sandstone (*a*) is found resting on gneiss, and dipping N. 58° W. $<$ 50°.

From Trainvain Brook, southerly, the rocks are of gneiss, bearing the usual characteristics of the Lower Laurentian series.

ECONOMICS.

Copper.

Native copper occurs very frequently in the manner described in giving an account of the distribution, among the *Ophiolites* of the Lewis hills, Bennois Brook, and Serpentine River; but it is remarkable that except in stains of green and blue carbonate, or perhaps occasionally in the form of red oxide, the ores of that metal were nowhere met with. Notwithstanding that, so far as our examination goes, such is the case, the mineral and lithological character of the magnesian group of rocks may fairly be considered as favourable to the probability of metallic ores existing at various parts of the country occupied by them; although the physical difficulties to be encountered in exploring the regions render it next to impossible for the explorer to examine all parts with such minuteness as to be enabled to discover and describe their position definitely. Unless stumbled upon by accident, nothing short of an *experimental* survey, conducted on skilful engineering principles, a necessarily costly and tedious process, is ever likely to develope

these hidden resources satisfactorily, and adventurers may be prepared for the expenditure of large sums of money before being in a position to open up a mine. Nevertheless, the fact that rocks of the same mineral quality as those so largely displayed over the region are known elsewhere to be almost invariably metalliferous, is sufficiently encouraging to attract attention; and there is every reason to suppose it probable that within the vast range of their distribution, which extends almost uninterruptedly to Bonne Bay, many mining localities may eventually be established.

Lead.

The manner of occurrence of the ores of lead at various parts of the peninsula of Port-a-Port is pretty fully given at pages 335 and 347, Report for 1873. At Lead Cove, where mining continues, a large amount of galena has been turned out from the crushed and broken Carboniferous rocks, through which the ore is very generally disseminated, but it being distributed through the mass in small crystals and rarely occurring in the form of prill, some difficulty and considerable loss is anticipated in the separation of the ore from the matrix. It seems highly probable, however, that a more solid and permanent lode may be struck in the subordinate Silurian rocks, when the upper and broken Carboniferous masses are worked through, the thickness of which cannot be very great. At page 335 of the Report just referred to, a set of parallel dislocations are shown to exist intersecting the Lower Silurian strata in which galena is often found in the form of prill ore, a good example of which was seen on the west side of Piccadilly in a fault of the Calciferous rocks, where the ore runs in solid bunches from 2 to 6 inches thick in a matrix of calcareous spar. A similar vein was seen cutting the Calciferous beds on the west side of Lead Cove, and many indications are known and many more reported, as intersecting the same formation on the southern shores of the peninsula as well as on the mainland of the second area. That the lead veins of the region are destined to rank high amongst the mineral products of the country, I see no reason to doubt; but it is scarcely necessary to state at the same time, that much more development must take place before such a result can be viewed in the light of certainty.

At a place called Red Rocks, between Trainvain Brook and

Cape Ray, solid prill galena was observed in quartz veins, the veins cutting the gneiss of the Long Range. Removal of the detritus, which to a great extent conceals the ground where the veins present themselves, will be required, before it will be possible to determine with any degree of certainty the character of the lode. The external appearances seem to warrant fair trial.

The following is a list of the places where indications of the presence of lead have been seen or reported. Those on the north side of St. George's Bay were seen by Mr. John Milne, F.G.S., to whom I am indebted for the information:—

1. A headland east of the Gravels beach near the fault, Report 1873.
2. In the limestone (Potsdam) west of the Gravels.
3. At Man-of-War's Cove.
4. At Perraway's Cove.
5. A cove adjoining the above.
6. At Abraham's Cove, west side of "Jerry's Nose."
7. At Ship Cove, with iron pyrites and *silver* reported (*doubtful*).
8. Lower Cove; small veins.
9. At Piccadilly; a fairly promising lode.
10. Smelt Brook; small veins.
11. Jack of Clubs' Cove, disseminated in Carboniferous.
12. Bellman's Cove.
13. Cove next adjoining 12; east from it.
14. Lead Cove, where the ore is worked as already stated.
15. Red Rocks, shore near Cape Ray in quartz veins.

Iron Ores.

The frequent occurrence of boulders of magnetic iron, and in the form of sand, was alluded to in last year's Report. Boulders of this were frequently seen on the east coast of Port-a-Port Bay in the beds of the several streams, and more particularly in the Bennois Brook, where they were very numerous. The sources from whence this ore is derived are most probably to be sought amongst the Laurentian hills; but whether it has in this case proceeded from the central anticlinal, where the Labradorites are supposed to come up, or been drifted from the coast of Canadian Labrador where it is well known, and to some extent worked in the manufacture of iron, is doubtful. The immense importance of its presence in these regions cannot be gainsaid, and seeing that there is every reason to believe that the Laurentian hills of Newfoundland are only a repetition or extension of those upon the

north side of the Gulf, similar substances may in all justice be reasonably expected. For a very full history of iron ores generally, their sources and the modes of deposit in the form of iron sand, I would refer to the very able Report of Dr. Sterry Hunt, F.R.S., p. 245, 'Report of Geological Survey of Canada—years 1866–69, inclusive.' For an account of the iron sands, see same Report, p. 261.

Iron Pyrites.

Solid bands of iron pyrites were observed among the Lower Silurian shales on the east side of Port-a-Port Bay, varying in thickness from 1 to 2 or 3 inches, and the same substance is very generally disseminated through all the metamorphic rocks of the region, probably in some cases in sufficient abundance to be of economic importance as a sulphur ore. It also occurs in huge masses and nodules among the Lower Carboniferous rocks, particularly where dislocated and near the contact with the Silurian strata. At Bennois Brook, iron pyrites is very abundantly scattered along the banks and bed of the stream. It also abounds in loose fragments and in nodules on the shores of Shoal Point, and at the head of West Bay.

Ochres.

Red and yellow ochres (peroxyd of iron) are abundantly found in the cracks and fissures of Carboniferous sandstone and marls. They are frequently used by the coast settlers as paint. Shell marl was seen at a few places, which is also used as a whitewash.

Petroleum.

The source of the petroleum of Shoal Point appears to be in the bituminous limestones, No. 4 of section No. 4, which rocks being largely distributed over the region, the substance may reasonably be looked for at many other parts. At Shoal Point the beds of limestone are rarely over a foot thick, and these, where broken, exhibit small drusy cavities filled with petroleum, while the exposed surfaces are pitted with small cells, encrusted with bitumen. The exudation which percolates through the sand possibly might be retained to some extent by means of a cofferdam to exclude the action of the tides.

Peat.

The immense extent of surface covered over by great deposits of peat is worthy of attention, as affording a ready supply of fuel for household and other purposes. Nearly the whole of Shoal Point is spread over by it, in thickness of from 6 to 8 feet; and the low parts on the east side of Port-a-Port Bay are similarly supplied. The banks of St. George's Bay between the Gut and the Little Barachois, and also at the Seal Rocks, are of peat, which extends back over a large area; and the cliffs facing the bay on both sides are often capped by a covering of the same material.

Gypsum.

The enormous development of gypsum within the Carboniferous areas of St. George's Bay was represented in last year's Report, p. 346. Many or most of the exposures of this material are unfavourably situated for exportation, in consequence of the lack of harbours; but some places are sufficiently accessible nevertheless. At Romain's or Kippen's Brook, vessels can anchor with safety during the summer months within a very short distance of the shore; and were a road constructed, as suggested in last year's Report, the great masses near the Cairn Mountain would become available and within easy reach of St. George's Harbour.

Salt.

The rocks and clays associated with the gypseous masses on Crabb's Brook, about 4 miles below the gorge where it leaves the Laurentian hills, were found to be encrusted with salt in a similar manner to that described in last year's Report, and the water issuing from the banks was brackish.

It is unnecessary to repeat what has already been stated with regard to other economic substances, in your Report for last year and for 1866, to which for further information I beg to refer.

I am, your most obedient servant,

JAMES P. HOWLEY.

To Alexander Murray, Esq., F.G.S.,
Director of the Geological Survey,
St. John's, Newfoundland.

CHAPTER XV.

REPORT FOR 1875.—SURVEY OF THE UPPER WATERS OF THE EXPLOITS RIVER—MINERAL AND OTHER RESOURCES IN NOTRE DAME BAY, &c.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, *February 29th*, 1876.

MAY IT PLEASE YOUR EXCELLENCY,—

I have the honour to inform you that during the past year (1875) the geological survey under my direction has made considerable progress, both as regards the immediate purposes of the investigation and towards acquiring a knowledge of the geographical features of the Island, which hitherto have been either quite unknown or greatly misrepresented. In consequence of my services having been required by the Government for special purposes, not immediately connected with the geological investigation, and I having had to frame three special reports thereon during the season, I have been unable to fulfil my intention of surveying and examining the Gambo country; neither have I, as yet, had time or opportunity for studying out the relations of structure as revealed by the collections and surveys of the late and former years. This Report, therefore, must be considered as merely preliminary, giving simply a general outline of the information acquired, to be followed, as soon as circumstances will permit, by a detailed geographical and geological history. In this latter connection my thanks are due to Mr. E. Billings, palæontologist to the Geological Survey of Canada, and to Principal Dawson, of McGill College, Montreal, for descriptions given of a collection of Silurian and Carboniferous fossils, which were forwarded to Montreal for identification, and were returned in November last. These fossils have proved not only of high scientific interest, as throwing some new light upon the fauna and flora of those periods, but will be of infinite practical value in developing the relation and sequence of stratification of the mineral-bearing formations. I have also to thank Mr. C. Bowring, M.H.A., for kindly forwarding

a collection of specimens illustrative of the rocks of Newfoundland to Professor Maskelyne, of the British Museum, for which I have been promised in return an arranged suite of illustrative minerals. These, when received, will form an important addition to the present collection, as affording opportunity for the study of mineralogy, and ready reference for the identification of crystalline forms.

The frequent and favourable indications of the presence of metalliferous ores in Notre Dame Bay, and the successful mining operations already in progress there, having of late attracted much public attention both here and abroad, I considered it my duty to make a re-examination of certain parts of that bay, in order to become acquainted with any new or previously undiscovered facts bearing upon the position of these mineral deposits, and to see conclusively how far my anticipations of former years were corroborated. For these purposes, after having started Mr. C. H. McLeod upon a meridian line as a basis for laying off timber limits on the Gander River, I visited certain localities in the Dildo Run, several of the various arms and inlets of Exploits Bay, Sunday Cove Island, Little Bay Island, the western arm of Green Bay, and finally made a rough survey of the Betts Cove location and mines. This latter operation, although by no means perfect, was satisfactory, inasmuch as it proved the position of the mine to be almost exactly on the line I drew on a map of my own construction in 1867, to show the probable position of the ore-bearing strata, guided as I then was by the presence of the great bands of serpentine. At a later period, having been requested by the Government to survey the south-west arm of Green Bay, in order to rectify certain disputes connected with the location of mineral lands there, an opportunity offered of extending the examination in that direction, and of inspecting the work commenced by the Hon. E. White.

Without going into a detailed account of the physical structure, which is reserved for a future occasion, I feel called upon to state that the experience of the late investigation convinces me more than ever that many of the northern parts of this island, and the great bay of Notre Dame in particular, are destined to develope into great mining centres, should capital and *skilled* labour be brought to bear in that direction. The frequent repetition of the

mineral-bearing strata associated with serpentine, chloritic slates, and diorites, maintaining a nearly uniform character throughout their distribution, and invariably exhibiting metalliferous indications, all seem to warrant the expression of such an opinion; although at the same time it must not be taken for granted that every individual spot where indications of this nature present themselves should necessarily prove of equal productiveness.

Although for the present it is premature to enter particularly into structural detail, perhaps a few hints upon that subject for the benefit of future explorers may be acceptable, and especially as applied to Notre Dame Bay. In many of my former Reports it will be found that in describing the position of the metalliferous deposits, I had observed that they were invariably found amongst strata nearly related to or associated with serpentine; consisting largely of chlorite slate, diorites, and dolomites. In the Notre Dame region these strata appear to be repeated over and over again by a series of great undulations, the axes of all of which point in a general north-east and south-west direction; with many minor and complicated folds, twists, and breaks within. Apparently beneath all these there are a series of slaty rocks with bands of red jasper and occasional strata of altered conglomerate, which sometimes assume a basaltic character, with a rudely columnar structure. The whole mass is intersected by great intrusions of a granitoid rock, in some cases probably *gabbro*, and by dykes of greenstone and other forms of trap. Some of these granitic intrusions are of a bright brick-red colour, and chiefly composed of orthoclase, others are pinkish, and many are grey, in some parts a pure granite. The traps are often jet black, or nearly so, and coarsely crystalline; they are also frequently of a rusty brown colour, weathering to a yellowish tinge, soft and earthy, giving an argillaceous odour on fracture. The ores of copper, usually sulphurets, are found disseminated or in layers with iron pyrites in the chlorite slates and dioritic beds; but the more solid and valuable ores are concentrated in the folds and dislocations (particularly in the magnesian portions), by which the formation has been affected. The ores are also of frequent occurrence in white quartz veins near the same horizon. The surface rock where these deposits exist is usually of a reddish rusty-brown colour, scored by remarkable minute reticulations, which weather in relief, giving a marked

and peculiar aspect which once seen is easily recognised, and may serve as a pretty trustworthy guide to explorers in making preliminary examination of the ground.

In addition to the ores of copper, ores of nickel, magnetic, chromic and specular iron, lead and sulphur ores in abundance occur, and traces of the precious metals have occasionally been found by analysis, always near the same horizon. The usual form of the nickel ores is that of arsenical or copper nickel, but it also occurs as millerite, or nickel pyrites; and as *cloanthite* (?) or an allied species, which is of a steel-grey or pale ruby-red colour. These nickeliferous ores have hitherto only been discovered in workable quantities at Tilt Cove, but small specimens have been seen at several other places, and they have invariably been found by analysis to be present in the serpentines. In my first Report for 1864, at page 35, will be found these words:—"The investigations made by Dr. T. Sterry Hunt, the chemist and mineralogist of the Geological Survey of Canada, have shown that traces of chromium and nickel appear to be almost universally diffused in the serpentines of the Quebec group in Canada, and in the United States; and analyses made by him of several specimens from Pistolet Bay and Little Bay indicate that the serpentines of Newfoundland will not be an exception. It is, therefore, reasonable to expect the occurrence of these metals in available quantities in the island." At Tilt Cove a considerable amount of nickel ore has already been extracted from the mine and exported to Swansea, where a portion was found to yield about 24 per cent. of metal to the ton of ore, which, at the valuation of 6*l.* sterling per unit, gave the handsome return of 141*l.* sterling per ton. It has been found that the matrix of these nickel ores is usually calcareous, and that a mass of steatite or soapstone is in close proximity.

The ore-bearing parts of this group of rocks, marked also by the presence of serpentine, soapstone, or magnesite, show themselves at each of the projecting peninsulas which separate the minor bays of the Great Bay, and also on the group of large islands off the entrance to Hall's Bay. They were recognised in the south-west arm of Green Bay, at the western arm, and the southern arm, in Little Bay and Hall's Bay; and also in Sunday Cove, Pilley's and Triton islands; in each case giving fair metallic indications well worthy of being carefully tested by experiment.

It was further observed, however, that the same rocks became barren of ore, or at all events it was more widely disseminated, when they came in contact or nearly approached the granitoid intrusions; which latter appear to be destitute of metalliferous material, except iron pyrites, which mostly occurs in intersecting quartz veins.

It is much to be regretted that the late marine survey so admirably accomplished upon the eastern coast as far as the Twillingate islands by Captain Kerr, R.N., and his assistants, was not carried on to the Bay of Notre Dame; as many parts of the coast both of the mainland and of the islands, as laid down upon the old charts, have recently been proved to be inaccurate to a grave extent in the detail, and in some cases even in the position of well-marked headlands. By the system which has been adopted for laying out lands for licences of search for mineral and mining grants, this defect is likely to lead to serious consequences; as these erroneous representations have hitherto supplied the only data for blocking off the lots, many of which will be found upon actual survey to interfere with each other, and occasionally in considerable parts to be non-existent as dry land altogether. The method adopted for the distribution of these lots, I have long and frequently taken occasion to show, was upon a bad principle, and one which must sooner or later inevitably lead to inextricable confusion and litigation; engendering a mischievous tendency to frustrate the advancement of an industry which ought to be encouraged by every possible means, as one of the very first importance towards the future well-being of the colony. Already disputes have arisen, and many more are likely to arise unless some speedy remedy is supplied to counteract the effects of this glaring evil; and the only means by which this can be done, so far as I can see, is to block off those portions of country not already under licence or granted, in the manner I recommended in my Report for 1867, and again in my evidence before a select committee of the House of Assembly in 1869. That under any circumstances each individual licence or grant already issued should be properly and carefully surveyed, ought now to be sufficiently evident; and in making those surveys the position of each starting-point must be accurately fixed *from some prominent natural feature*, and not merely be dependent upon the termination of a neigh-

bouring location which may or may not be correctly established. In case of one location interfering with another, which will no doubt frequently happen, I would suggest that preference of right over the specified area should be given according to priority of date of the title-deeds held by the respective parties.

To accomplish such surveys as I recommend, will require the services of competent surveyors, as the so-called surveys of locations made hitherto are more apt to mislead than to convey any definite idea of the real boundaries, or the areas those boundaries are suppose to contain. The only instrument used, that I am aware of, by the present Deputy Surveyors is the compass, trusting entirely to the needle, an imperfect instrument at best, but worse than useless in a country where local attraction of the magnet is the rule rather than the exception, and which at some parts prevails to such an extent as to render its use for any practical purpose impossible. At Tilt Cove, for example, I found the deviation so variable, that at no two stations which I took up on my triangulation was it the same; and at one point, namely on Castlerock Pond, I found its intensity so great as to make a difference, within 6 or 7 paces, of no less than 60°. At the same time the captain of the mine who, for want of a proper dialling instrument, had used the needle in his underground work, found it so impossible to reconcile it with his surface plan, that he had recourse to making a rough estimate of his angles by means of a common foot rule in preference.

The serpentine and associated rocks almost invariably contain more or less magnetic iron, and many of the trap rocks and diorites are themselves magnetic; consequently the needle is affected according to the intensity or proximity of those materials wherever the metalliferous strata occur. In my recent survey of the south-west arm of Green Bay, this local attraction was observable at several points; and the result of four separate observations, taken at the point called Nicky's Nose, was to show a local deviation from the normal variation of about 3°. Suppose then a line were to be run by compass due south from this point for 1 mile, the termination of that line would be nearly 5 chains out of its true position; and even that amount of error could not be relied upon, unless it were proved that the local deviation was constant over the whole distance.

Mr. Howley's Survey.

Mr. Howley having been instructed to make a survey of the upper valley of the Exploits River, in continuation of the survey made by myself in 1871, left St. John's with a crew of three Indians by the s.s. *Leopard* on 27th June, and landing at Twillingate (or Toulinguet) on the 1st July, he then proceeded to Upper Sandy Point by a small sailing vessel, where he arrived on July 3rd. Here he expected to meet two more Indians who engaged to cross over by land to meet him from Bay D'Espoir, but they failing to arrive, he was compelled to engage two others, residents at Wigwam or Upper Sandy Point, to convey his stores and camp equipage up the river. The Bay D'Espoir men, however, arrived shortly after he had left, and overtook him at Badger Brook, about 35 miles up the stream, and thus his party was completed. While at the latter place, Mr. Howley took the opportunity of measuring up the brook as far as it was accessible for his canoes; and afterwards by ascending to the summit of Hodge's hill he obtained a magnificent view of the surrounding country, and was enabled to get a series of angles all round, many of which were upon well-marked points, partially or fully determined on our former surveys. Prominent among these points was Mount Peyton, or the Blue Mountain Tolt, from the summit of which a set of observations was taken by myself in 1874, while engaged in surveying the Gander country. Mr. Howley then proceeded with all possible dispatch up the stream to the Red Indian Lake, and there commenced his survey by measuring the Victoria branch of the river, which he ascended on foot about 31 miles. Thence he crossed over the country direct in a course about N. 30° W., to the upper part of the Red Indian Lake, which he struck nearly opposite the point where my survey terminated, and from which he took his departure for the survey of the Exploits proper. This stream he followed, after having completed the survey of the lake, which terminates 9 miles above Station H of my former survey, for about 72 miles along its course. This distance includes two lakes of considerable size, viz. Lloyd's Pond and King George IV. Pond, which were also minutely surveyed in detail. He ascended all the more prominent hills bordering on the valley, from whence he was enabled to connect the triangulation, and to get bearings

upon other important geographical features. From the banks of the river, 23 miles above King George IV. Pond, the measurement was continued across the country to Lapoile, the distance traversed in an air line, to his junction at high-water mark, with Captain Orlebar's survey at the head of the main inlet of Lapoile Bay, being 20 miles. He then recrossed to King George IV. Pond, and thence, having portaged over to the Victoria branch, he continued his course down the latter stream, passing through and surveying the Great Victoria Lake, until he joined the work previously accomplished. The total distance measured upon the Victoria branch, including the length of the lake, was about 63½ miles. Finally, Mr. Howley returned to the Victoria Lake, whence he crossed the country to the head waters of the White Bear Bay, and descended ultimately to the coast by the valley of Grandy's Brook, arriving at the telegraph station there upon the 27th of October.

Geographical Description.

The complication of the drainage waters at the south-western angle of this island, forms a very remarkable geographical feature. The main drainage of the region flows to the north-east by the Exploits River, over a distance of nearly 200 miles in an air line, while the south falling streams, which are numerous and large, take their rise in many cases, in close proximity to the waters of the Exploits, and on the same level, and thence find their way in turbulent torrents to the sea in a straight distance of sometimes less than 20 miles. The tributaries of the Exploits which flow into the main river from the westward interlock with the Great Codroy and the various rivers of St. George's Bay. The main river or Exploits proper takes its rise in the country lying in the forks of the eastern and northern branches of the Lapoile, and at a distance probably of not more than 12 miles in a straight course from the sea-coast, and not less than 1500 feet above the level of the sea. On its way downwards, near where the surveyed line passed, the water which drains into the north branch of the Lapoile on the one hand, and those which fall into the Exploits on the other, were found to be within a few yards. The general course of the Exploits downwards from that point is a little eastward of north* for about 8 miles, and thence nearly due east

* Bearings are all from the true meridian.

about 9 miles till it enters King George IV. Pond; but in those distances there are many sinuosities and sweeping bends in getting round the mountain ridges and spurs. King George IV. Pond, (known to the Indians by the rather appropriate name of Cross Pond, from its greater length lying nearly at right angles to the general course of the river), is of an irregular shape, being indented by many bays and coves; it contains an area of about 8 square miles, and lies 1237 feet above high-water mark. From this lake the course of the river is remarkably straight in a north-easterly direction, till it joins the Red Indian Lake at the end of upwards of 40 miles. Sixteen miles above Red Indian Lake the river expands into Lloyd's Pond, which is 6 miles long by an average breadth of about three-quarters of a mile, with an area of nearly 5 square miles, and at an elevation of 620 feet above the level of the sea. By my estimate in 1871, the height of the surface of Red Indian Lake was placed at 428 feet; but by the levels brought up by the Railroad Engineers, from St. George's Bay, it was found to be 481 feet.

The Victoria branch of the Exploits takes its origin between the White Bear and Grandy's Brook waters, which interlock each other, and the eastern branch of the Lapoile, and it flows generally nearly parallel with the main river to its junction with the Red Indian Lake, about 4 miles above the outlet. South-west from that junction at the end of 47 miles, the river expands into a magnificent sheet of water called Victoria Lake, which is 16 miles long by a breadth of about three-quarters of a mile. Its whole area, including a bay about 3 miles long and over three-quarters of a mile wide, is nearly 20 square miles, and its elevation above the sea is 1160 feet.

At the divide, and indeed throughout the whole region south from King George IV. and the Victoria Pond, the country may be described as one vast desolation of bare rock, being covered only on the leveller parts by marsh, or occasionally near the lakes and watercourses by the thinnest of soil, supporting only deformed and stunted bushes. Indeed, so destitute was the country passed through by the party between the head waters of the Exploits and Lapoile Bay, and also between the Victoria Lake and Grandy's Brook, that at most parts neither poles nor brush could be procured

for constructing a camp, and the only firewood to be obtained consisted of the small gnarled bushes that were sprinkled here and there.

A lofty range of rugged and precipitous hills separates the two main branches of the Exploits, which rises abruptly from the right bank of the main stream, but slopes more gradually towards the Victoria, where at some parts a fringe of well-timbered land occupies considerable areas back from the left bank of the river. This range averages a width of about 5 miles, some of the higher elevations upon it reaching to a height of over 2000 feet above the level of the sea. A gorge is cut through this range by the main river between Lloyd's Pond and Red Indian Lake, which thence bears away north-easterly towards Lobster House and the adjacent heights south-east of the Grand Pond. A narrow fringe of interval land occurs on the main river below Lloyd's Pond, which widens at the confluence of the small tributaries; the country on the north-west side rising very gradually, and giving a tolerably level surface up to George IV. Pond.

For about 16 miles up the valley of the Victoria branch of the Exploits the ground is irregular and rocky, and the river much broken by falls and rapids; but above that distance the country greatly improves, and a large tract, well wooded, generally level and covered by a good soil, prevails nearly up to Victoria Lake. This level and reclaimable land seems to extend to the eastward with few interruptions to the Great Rattling Brook, as shown by Mr. Austin's description of the line he ran upon the railway survey; and it appears probable that a similar character will be found to exist, to a large extent at least, between that line and the bank of the main river. (See my Report for 1871, upon the Exploits country.) In describing the view from the summit of Hodge's hill, Mr. Howley says, that while the regions towards the north and east, and also to the north-west, consist chiefly of marshes and barrens, scattered over partially by woods, the country away to the southward and on the southern side of the Exploits, presents an unbroken dense forest in a series of gentle undulations as far as the eye can reach. Mr. Howley also describes the country he crossed on his expedition from the Victoria River to the head of the Red Indian Lake, as well timbered throughout, although

very elevated at some parts, his summit level reaching 1600 feet, while Costigan's Pond, a large lake which lay in his track, was 1200 feet above the level of the sea.

By reference to my Report for 1871, upon the Exploits below the Red Indian Lake, at pages 257–259, it will be seen that a very great part of the lower valley is described as being well wooded, generally level or gently undulating, and usually of a fairly productive soil. From what Mr. Howley has ascertained, and from the description given by Mr. Austin's party of the country passed through by the railroad line, between the upper end of the Red Indian Lake and the Great Rattling Brook, there would appear to be a tract of land, more or less reclaimable, at least 50 miles long by an average width of 15 miles, which would comprise an area of about 750 square miles. If to that we were to allow, say 50 square miles of similar country for the lower Exploits valley, Peter's Brook, and Norris' Arm, there would be 800 square miles upon the Exploits alone, more or less capable of supporting settlement. The pine timber, spruce, tamarack, and birch, over extensive areas is reported to be of excellent quality and vigorous growth, and all of these might become available were those regions opened out by main lines of road, for the construction of which no perceptible difficulties present themselves. In Report for 1870, at page 230, it is shown that the mineral character of the rocks over a wide area immediately south from Mr. Austin's line at the Great Rattling Brook, is indicative of the presence of various metallic ores; and at page 219 of the same Report, communication thence with the coast at Bay D'Espoir is suggested by means of a road being laid out along the route followed by the Indians between the latter and the Exploits.

The telegraph line here hinted at appears at length about to become an accomplished fact; and if that means of communication is duly followed up by establishing a good main line of road, a great step in the direction of enlightened progress will be secured, affording means and opportunity for the development of the varied and valuable material resources of the country.

The tracing which accompanies this Report is a reduction from surveys made by Mr. Howley and myself to a scale of 4 miles to an inch. Upon it will also be found the routes followed by the Railroad Engineers between St. George's Bay and Come-by-Chance

in Placentia Bay; Mr. Ramsey's Section A and Mr. Lynch's Section C, being reduced directly from their actual survey; while Mr. Austin's Section B (whose plans were not placed in my hands, as were the others) is fairly approximate. It has been found upon plotting that the result of all these separate and independent surveys is very satisfactory. With the exception of an apparent slight discrepancy in longitude, where in the extension of the sundry surveys our protraction brings us out to the coast in Exploits, all our evidences point to almost absolute accuracy; but seeing that the charts of that region, which are the only data we possess for such longitude, are known to be in considerable measure inaccurate (as I have already stated), it still has to be proved whether this error has crept into our own work, or is due to the original survey of the coast. The error now alluded to amounts to between one and two minutes of longitude, our protraction being to that extent *west* of the longitude laid down on the chart; but the result of a great number of observations taken for latitude throughout Mr. Howley's and my own surveys, all of which agree with the positions found by protraction, goes far to show that the latitudes given on the chart of Exploits Bay are placed *too far south* by upwards of one minute. In order, therefore, to make the surveys of the interior harmonise with the published coast maps, we have lengthened our lower reaches of the Exploits to the longitude there given; while we have retained the latitudinal position as found by ourselves.

It will be seen that the map is made to embrace the whole width of the island, between the Bay St. George and the eastern coast, and that portions of the southern coast are introduced from the accurate coast surveys of Captain Orlebar, R.N., and W. F. Maxwell, Esq., R.N. This area includes the work accomplished by the Geological Survey at sundry times, and to be found described in the Reports for 1870, 1871, 1873, and 1874, to which, for further information, I beg to refer your Excellency. The survey for 1875 has already been described geographically at a previous part of this communication, and some reference to the same subject will also be found in my summary Report upon the survey of the Railroad Engineers. As regards the distribution of the geological formations throughout the regions last explored by Mr. Howley, they will be found indicated also upon the surface of the map;

but before entering particularly into a detailed account of these physical characteristics, much more careful study of the specimens collected, and of all the facts which have been ascertained, than we have as yet been able to bestow upon these subjects, will be required.

With the exception of the ores of iron, which probably will be found to exist at certain parts of this same region, and possibly apatite or phosphate of lime, I am not in the meantime disposed to consider its mineral capabilities of much importance.

I have the honour to be,
Your Excellency's most obedient servant,
ALEXANDER MURRAY.

To His Excellency
Sir Stephen J. Hill, C.B., K.C.M.G.,
Governor of Newfoundland, &c., St. John's.

CHAPTER XVI.

REPORT FOR 1876. — RETROSPECTIVE REMARKS — LIST OF MS. MAPS — MR. HOWLEY'S SURVEY OF THE UPPER GANDER, AND GAMBO WATERS.

GEOLOGICAL SURVEY OFFICE,
December 29th, 1877.

MAY IT PLEASE YOUR EXCELLENCY,—

The progress made upon the survey under my direction in recent years, especially as regards geographical and topographical detail, has been so extensive, that a new edition of the small-scale map published in 1872 has become a necessity for public information. A paper, dated 13th October, 1873, shows that a second edition was then contemplated, which, being now accomplished, I beg to lay before your Excellency in hopes of approval.* A

* GEOLOGICAL MAP OF 1872-3.—The frequent demand that has been made for information upon the general structure of this island has induced me to issue a limited number of copies of this map for present reference, which it is to be hoped will be found useful and instructive. I think it advisable, however, to let it be publicly understood that the present issue is only a *first* and by no means perfect edition, and that a future edition, which will accompany a report of all that has been ascertained by the Geological Survey since its first inception, and will contain many additions and modifications, both in topography and geology. In the meantime I have the satisfaction of being able to state with confidence, that in regard to geographical detail, both of the contour of the coast and of the interior topography, this is by far the most accurate map extant. Through the kindness of Staff-Commander Kerr, R.N., Lieutenant Maxwell, R.N., and the other officers of the Admiralty Coast Survey, I was permitted to have access to all the most recent work done in their office, which was carefully reduced to this small scale, and comprises the eastern and south-eastern coast, between Notre Dame and Placentia Bays; while the western and south-western coast was reduced from the surveys of Captain Orlebar, R.N., Captain Cloué of the French Imperial Navy, and my own. The topography of the interior (i. e. all within the coast-line) is entirely the result of my own labours, or done immediately under my direction. With regard to the distribution of the geological formations, it will be clear to any one at all conversant with the difficulties attendant upon drawing in boundary lines with accuracy, especially in wild, unknown, or unfrequented regions, that many alterations and modifications will hereafter be necessary before the map can be considered by any means complete; nevertheless, I feel tolerably sure that the approximation is such as to be of considerable service for present purposes, and will be a useful guide for future and more minute investigation of details. The colour and number representing Lower Laurentian will require modification in several parts, as will also the Coal Measures, and probably the Middle

comparison of this new map with the former issue will readily show the amount of addition and modification the original plate has undergone. In the meantime, moreover, the accumulation of manuscript maps upon various scales in this office has become so cumbrous and voluminous, that an index map was felt to be absolutely required. In order to expedite the engraving and colouring of this map, it was evidently desirable that I should be on the spot when the work was to be executed, to supervise these operations, as otherwise (the plate being in England), proofs after proofs would have to cross and recross the Atlantic, involving much loss of time, causing a good deal of extra expense, and probably at last proving unsatisfactory. I accordingly proceeded to England in the month of May last, and immediately on arrival in London, put myself in communication with Mr. E. Stanford, of Charing Cross, who had executed and still retained the original copper-plate, and to whom I gave the necessary instructions for a new engraving, with tracings from all the additional works accomplished. This map comprises all the most recent coast surveys, taken directly from the original manuscripts of the Admiralty Surveyors, several coast surveys of considerable extent made by ourselves, and the whole of the geographical features of the interior country, which have been surveyed in connection with the geological investigation. The line of survey for a railway as run by transit and level by the Railway Engineers, in 1875, is also correctly represented. All these surveys were first reduced from scales of various sizes, to a uniform scale of 1 inch to 1 statute mile; then again to a smaller scale of 4 statute miles to 1 inch; and finally, to the index size of the present publication; all of which work was draughted in this office, the manuscripts being filed and labelled, ready at any time for inspection. In order that

and Upper Silurian; and I observe that by some inadvertence, a wrong colour has been introduced upon the north side of Smith's Sound, in Trinity, which, instead of being *Trap* or *Syenite*, is *Primordial Silurian.*

An extensive survey of the Carboniferous country surrounding St. George's Bay was made during the past summer, which I shortly intend to publish on a scale of 4 miles to 1 inch. Much of the coast-line at these parts being found to be very defective upon the older maps, was re-surveyed, and many of the most important rivers were dialled, while the whole was brought into connection by triangulation. All these alterations and corrections will appear in the new map, together with some most important facts which were ascertained with regard to the distribution of the coal measures.—ALEXANDER MURRAY.

the public may be made aware of the existence of such documents, I subjoin a list of the MSS., with the scales of each, to which any person can have access for reference at any time in weekdays, while the officers of the survey are in St. John's.

Manuscript Maps at Geological Survey Office.

Particulars.	Scales. Inches.		Scales. Statute Miles.
1. Original survey of a part of the peninsula of Cape St. John to Notre Dame Bay	4	to	1
2. Part of the above No. 1	4	„	1
3. Coast near St. John's Harbour, road surveys, &c.	2	„	1
4. South-west arm of Green Bay	2½	„	1
*5. Peninsula of Cape St. Mary	1	„	1
*6. Part of Placentia Bay from Little Placentia to Come-by-Chance	1	„	1
*7. Coast-line between Cape Spear and Killigrews Head, Conception Bay, with roads, &c.	1	„	1
*8. Conception Bay	1	„	1
*9. Trinity Bay	1	„	1
*10. Peninsula of Cape St. John	1	„	1
*11. Gander Bay	1	„	1
12. Gander Lake and Rivers, county of "Hill," &c.	1	„	1
13. Gander Rivers above the Lake and tributaries, with Gambo Ponds, rivers and tributaries	1	„	1
14. Humber Rivers, Deer Lake, &c.	1	„	1
15. St. George's and Port-a-Port Bays, with rivers, &c.	1	„	1
16. St. George's Harbour and Flat Bay, Indian Head, &c.	1	„	1
17. Codroy Rivers	1	„	1
18. Peninsula of Port-a-Port, coloured	1	„	1
*19. Southern coast between Burgeo and Little River	1	„	1
20. Exploits River, Victoria River and Lake, and traverses across from ditto to Lapoile and Grandy's Brook	1	„	1
21. Piper's Hole and part of Placentia Bay	1	„	1
22. Rocky River, with part of Trinity, Conception, and St. Mary's Bays	1	„	1
23. Western coast from Cape Anguille to Cow Head, Grand Pond, Indian River; Exploits River and Red Indian Lake; coast of Notre Dame Bay to White Bay, &c.	1	„	4
24. West coast from Cape Ray to Bonne Bay, Codroy River, Flat Bay and Brooks; Humber River and Grand Pond	1	„	4
25. Bay East, Terranova and Piper's Hole Rivers	1	„	4
26. Coast of St. George's and Port-a-Port, with surrounding country	1	„	4
27. Port-a-Port Bay, with serpentine rivers	1	„	4

Particulars.	Scales. Inches.		Statute Miles.
28. Bonavista Bay and part of Notre Dame Bay, Terranova, Gambo and Gander Rivers	1	to	4
29. Gander Lake and Lower River, laid off in townships ..	1	„	4
*30. Notre Dame Bay	1	„	4
31. Indian River and Grand Pond	1	„	4
32. General Map of Newfoundland in skeleton	1	„	4
33. General Map under construction	1	„	7
†34. Cape Breton Island	1	„	7
35. Original small-scale General Map	1	„	25
	Inches.		Chains.
36. Original survey of Tilt Cove location	1	„	4
37. Plan of levels of No. 36, scale 20 feet to 1 inch.			
38. Original survey of Terranova mining location	1	„	4
39. Plan and section of Harbour Grace Lighthouse Island	1	„	2

In addition to which there are many tracings taken from original surveys upon various scales.

N.B.—The coast surveys marked * are reductions from the Admiralty surveys. Copies executed elsewhere than in this office are marked †.

While in England, I had an opportunity, long wished for, of having several of my most necessary surveying instruments repaired by the maker, H. Porter (late Cary), of London, which after upwards of twenty years of constant service they greatly required.

Before leaving St. John's, I sent the following letter of instructions to my assistant, Mr. James P. Howley, whose report upon the country he examined and surveyed is appended.

Geological Survey Office,
St. John's, *May 1st*, 1876.

My dear Mr. Howley,—Until the season opens sufficiently for carrying on operations in the field, I wish you to employ yourself in arranging the specimens in the museum, and getting them catalogued in the same way as was done formerly. Any alteration that may have been made to be notified in the general catalogue. The specimens collected during last season must be labelled and boxed, and the box marked 1875. The duplicate printed labels can be used in the catalogue as before.

As early as possible in June, my desire is that you proceed to

the Gander country, to survey as far as you can the upper branches of that river above the great lake. I have already written to Mr. Peyton, of Twillingate, to engage the services of Charles Francis (Indian), to accompany you; but I told Mr. Peyton, at the same time, that there had been some serious complaints made against Francis to the Government, which, unless he could clear himself of, I might scarcely be justified in giving him employment. This matter you can investigate on the spot. For my own part, I believe he is more "sinned against than sinning." If you can get another Indian from Conne to cross over and join you on the Gander (Peter Stride, for example), do so, and I think, of course, you will have John Stephenson; but as I have been instructed by the Government to keep all our expenses at a minimum, I must caution you to avoid having more men than are absolutely required, or of incurring any extra liabilities. Two canoes for your services you can take with you; the larger and new one I should like to retain for my own use when I return. Should you not require the two when you get to the Gander, you can get one of them stowed at Francis' or some other safe place at the salt water; or should you take both up to the lake, and find one sufficient afterwards, get the extra one well housed in, at some sheltered place on the lake. I hope to be back to Newfoundland in July, although a good deal will depend upon the forwardness of the work I have to do in London, and as soon as I return, my intention is to proceed to Freshwater, Bonavista Bay, and there commence a survey of the Gambo. About August, if you can manage to get across to the Gambo waters, we may probably meet there, and afterwards work together.

Geologically, I am particularly anxious to learn the boundaries of the Laurentian with the Huronian systems; and of the Huronian with the Lower Silurian, a great spread of the latter being apparently of the age of the Quebec group. Unless we have the luck to discover fossils, the latter boundaries will be found very obscure; but close examination will, doubtless, reveal a great deal of useful and interesting detail. Take special note of the character of the forests and of the soil. I think you ought to supply yourself with a sheet or two of zinc, some copper tacks, and resin, in case of requiring to mend or patch your canoes.

I shall have a credit of 100*l.* for you at the Union Bank; you can get a cheque-book and pay all your accounts *at once.* Tell the parties from whom you get your goods to send their bills in at the same time they send the supplies, to be settled without delay. The receipts you can put up in an envelope addressed to me, which I shall send with my own account to the Colonial Secretary on my return. These papers will be put into their proper place in my office.

Wishing you a prosperous season, and hoping to meet you at the time appointed,

I am, yours truly,

ALEXANDER MURRAY.

To Mr. Jas. P. Howley,
Assistant Geological Surveyor.

Shortly after my return to St. John's in August, I made preparations for the expedition up the Gambo, in accordance with the arrangement made with Mr. Howley, as indicated in the above instructions, but finding it difficult to obtain any means of conveyance for myself, men, and equipage direct to my destination, I gladly availed myself of the kind offer of Mr. Justice Hayward of a passage by the steamer *Hercules*, at that time engaged to carry the Judge and counsellors on the northern circuit. After some unavoidable detention, partly occasioned by the very unfavourable state of the weather, I was at length landed at Greenspond on 13th September, when I immediately hired a small vessel to carry me to the Gambo at the extreme head of Freshwater Bay, where I arrived on the night of the 14th. Finding that Mr. Howley had already ascended the Gambo, he having crossed over from the Gander Lake and continued his survey as he advanced, the measurement I had contemplated making up that stream became unnecessary; but I resolved to follow up the river as far as practicable, in order to be enabled to give an account of the physical characteristics of the region from personal inspection, and to compare them with those of the Gander. As a detailed account of the Gambo waters and the surrounding country will be found in Mr. Howley's report to me, I need only remark here that as a lumbering country it appeared to possess many advantages,

while large tracts, especially on the beautiful river flats or interval lands, are admirably adapted for the pursuits of agriculture. The pine timber on or near the Gambo waters is more scattered, and generally of smaller dimensions than on the Gander Lake and upper waters; but there appears, nevertheless, to be an abundant supply of the material, which, judging from the numerous logs cut, and being floated down the river, as well as the appearance of the trees standing, is of excellent quality. The white birch timber also, which is very abundant, seems to be of the very best description, sound and solid, many trees of which were seen to exceed 2 feet in diameter, and carrying their thickness upwards before bifurcation for 15 feet or more. White spruce and fir of good growth constitute the greater part of the forest, which, except where destroyed by fire, densely covers the ground nearly to the top of the hills on either side of the river and its tributaries.

Two saw-mills are already established on the Gambo, one driven by steam of 25 horse-power, the other by water. The former of these is situated at the mouth of the river, conveniently for loading the lumber direct into sea-going craft; the latter is about a mile above the outlet of Mint Brook, which flows into the lower Gambo Pond. The lower mill has been in operation for several years, but failed to be a profitable speculation, not from lack of material to supply it amply with logs for lumber, but from ignorance and inexperience of the requisite construction on the part of the proprietor, whose capital, moreover, was insufficient for the necessary preliminary outlay. The water mill on Mint Brook was unfinished at the time of my visit; but it bore all the appearance of being at length an admirable building—capable of extensive operation. Like the other in some respects, as well as various attempts of a similar nature in this country, many serious mistakes were made, and much unnecessary expense incurred, in the first instance, in the construction of the dam and other requisite adjuncts for the mill, which, if persevered in, might probably have proved disastrous to the undertaking altogether; but all these errors were eventually remedied by the judicious employment of a skilled millwright from New Brunswick, who from long experience saw at a glance the defects of the case, and suggested alterations which, there is little doubt, will finally put the concern in good working order. The pro-

prietors of these two mills, with very good reason, are confidently sanguine of their speculation becoming remunerative; and if their success is simply to be dependent on the quantity and quality of the timber, the issue would scarcely, under ordinary circumstances, be in the least doubtful; but I feel constrained to state that (judging from my former experience in Canada) the manner in which all this timber is obtained, is liable to great objection. There (in Canada), wild, unoccupied lands, were always considered to be primarily the property of the Crown, and the pine timber was ***exclusively reserved as Government property***, in some cases ***even after*** the surface had been disposed of for agricultural settlement, either by grant or sale. To avoid waste and destruction, and prevent collision of parties in search of timber to supply the various mills, the ordinary system was for the Government to grant licences to cut down, saw, or square pine or other trees growing over a certain area, varying from 20 to 100 square miles. These areas were required to be surveyed by competent Crown Lands Deputy Surveyors, who determined and marked the boundaries, the expenses of which surveys were arranged between the Commissioner of Crown Lands and the future lessees of the timber limits. In his operations, the lessee was compelled to conform to certain rules; first, to keep within the boundaries specified by the survey; second, when cutting out a line of road, to follow as nearly as circumstances would permit, a line that would eventually be made available for the permanent settlement of the land, in moderately sized blocks or lots, which would be represented on his plan; thirdly, I would suggest further, that cutting down pine trees under a certain diameter should be disallowed; and lastly, that the mill-owners should be held responsible for the conservation of the salmon and trout which frequent their respective waters; and that they should be compelled to place artificial means for ingress and egress of those fish, where dams or other obstructions are erected. These fostering cares for the future welfare of the colony are surely worthy of some consideration; especially as there are in the meantime so many inducements calculated to encourage, rather than suppress, reckless waste and destruction. Granting small areas, such as 100 or 200 acres or the like, in consideration of the grantee establishing a saw-mill, is, in my opinion, an unmixed evil; unless some means are taken by which the said grantee will be compelled to confine his operations

to the area granted. The result naturally is, that so soon as the timber on the given lot is exhausted (which a good mill would probably exhaust in twelve months), the woods are felled right and left indiscriminately; and the refuse, as well as many valuable trees (which if permitted to grow would in time have produced millions of feet of lumber), are left to cumber the ground in inextricable confusion. Many of the disastrous fires by which the country is so frequently devastated are probably due to those heaps of rubbish, which, after lying for a season, are as inflammable as tinder. I conceive that no system can be better adapted to simplify the laying off of such lumbering areas than that I proposed, and was to a limited extent carried out for the lands of the Gander. The meridian line, which was started from Salt Islet in Gander Bay, if continued south, would eventually strike near the head of the Upper Gambo Point; and a point from whence to continue the system of laying off blocks of 36 square miles each, can easily be found on that meridian, which is 54° 29′ W., by measuring a minute of longitude east from the mouth of the Triton Brook, which is in 54° 30′ W., almost exactly. The north-east angle of the block might be determined on this meridian, by measuring 34 chains north from the northern shore of the pond, which would place it in latitude 47° 38′ 30″ N., very nearly. Although the direct survey on a meridian, as commenced by Mr. McLeod, would undoubtedly be much more systematic and satisfactory than starting anew from another given point, I make the suggestion in case that the original scheme might at present be inconvenient to carry out; while it must be obvious that *some* plan must shortly be adopted to prevent confusion and disputes. The indiscriminate manner of carrying on lumbering operations at present, is not only objectionable, as destructive and wasteful, but will inevitably lead to collision between the rival gangs of men employed.

It is very gratifying to perceive that the statements made by Mr. Howley, in his Report for the late year, upon the capabilities of the Gander River and lake country, fully corroborate the representations I made of that region two years ago; and it is the more so, as the facts then announced give a direct and unqualified contradiction to statements made by designing or self-interested individuals who have spared no pains to throw doubt or discredit on my assertions. The estimate I once made of the quantity and value of timber in these regions is not by any means asserted as

an actually determined fact, and is only offered as a probable or possible approximation to the reality; but it may at the same time be understood that in making that rough estimate I was guided not only by what I actually saw in the region in question, but by the opinion of an experienced and most highly respected lumber merchant of New Brunswick, who personally inspected the ground, and who proposed the most favourable terms to the Government of the day, for permission to cut timber over 50 square miles adjacent to the Gander Lake. The obstructionists who so diligently spread rumours to underrate the value of those fine regions are manifold; but there are two sets of individuals, in particular, whose accounts should be received with extreme caution. First of these are the so-called settlers, near the mouth of the river, whose sole occupation appears to be to destroy the salmon fishery by every sort of barbarous practice that can possibly be conceived; and, secondly, there are certain parties who designedly misrepresent facts in hopes of securing thereby the better terms for themselves. Warnings are said to be given to strangers visiting those parts, of the inutility of ascending the river, and assurances offered that the whole region is as barren of pine as the country surrounding the estuary and lower reaches, where, as everybody knows who has visited the places in question, every tree of any value has been culled out long since.

In a letter I had the honour to address to the late Governor of Newfoundland, Sir Stephen J. Hill, dated 4th January, 1875, I made strong protest against the wasteful destruction perpetrated on the so-called French shore, by cutting what is termed ton timber. Other evidences of the reality of the statements there made may be found in the official reports of Captain Howarth, R.N., of C. H. McLeod, Esq., C.E., and in a letter addressed to the 'Royal Gazette,' and dated at Bay of Islands, April 26th, 1875, by Mr. John Tupper. I regret to find that this wasteful and destructive proceeding is not entirely confined to the limits (whatever they may be) of that undefined and outlawed territory, but is practised upon *bonâ fide* Crown lands, under undisputed British jurisdiction. I was informed while at Gambo that a certain Captain Wright, of Liverpool, had cut ton timber on that river, and brought to market in 1875, 583 tons of the same; and it is rumoured that similar operations are now going on at the Gander Lake. Were those lands located as timber limits, the evident

interests of the lessees would be sufficient protection against such unjustifiable abuses.

Mr. Howley's Report shows that the fertile lands of the Gander extend over a large area, above as well as below or on the banks of the great lake, especially in the valleys of the south-west branch and some of its tributaries; and it further shows that there is an area of at least 300 square miles, where pine, although scorched by fire, still stands in a perfectly sound condition, capable of yielding an enormous supply of excellent timber.

At page 363 Report for 1874, the remarkable facilities for connecting Gander Lake with Freshwater of Bonavista Bay, by means of a tramroad, were adverted to; the only difficulty which then presented itself for such a construction being the fallen and burnt timber which encumbered the ground. This tract of about 9 miles was crossed by Mr. Howley, as will be seen in his Report, who found that the whole, or nearly the whole of the encumbrances occasioned by the first fire had been swept away by a more recent conflagration, and left the ground clear of all obstructions. He crossed by the valley of a stream known as the Middle Brook of Freshwater Bay, on the waters of which he found a fine pond; and at or near the outlet into the salt water, a good site for a saw-mill. He also represents the soil of the valley of Middle Brook and between the pond and Gander Lake to be, for a great part, of very good quality.

Geological Memoranda.

At page 365 of my Report for 1874, the presence of serpentine, chlorite slate, and diorites is shown to occur upon the Gander Lake, associated with mica slates; a great thickness of the latter apparently underlying the former. There is much obscurity, however, as to the structural relation of these rocks; and the total absence of organic remains renders the recognition of horizon perplexingly difficult to determine; yet the lithological resemblances appear still in favour of the probability that the magnesian portions are representative of a portion of the Quebec group. The colour of the magnesian rocks varies from a very dark green, through all shades of green to nearly white; and they are frequently characterised by the presence of a fibrous serpentinised *actinolite*, sometimes exhibiting fine veins of *chrysolite*. Grains of

magnetic and chromic iron occur occasionally, and portions are more or less calcareous. It may now be observed that similar relations of strata are recorded at page 32 of my Report for 1864, where a great mass of mica slate is described as having been seen to underlie the serpentine and associated rocks at Little Bay near Terra Nova mine; and that the resemblance which exists in the characters exhibited at the two widely separated localities seems to warrant the suggestion that they are probably of the same age. On the western and northern parts of the island, we have in former Reports shown tolerably clear evidence to prove that a great accumulation of magnesian rocks with serpentine rests unconformably upon strata containing abundance of fossils, representative of the Calciferous and Levis formations, which want of conformity, if admitted in the case of the Gander country, might explain the apparent absence in that region of the subordinate Lower Silurian members. It will be seen by Mr. Howley's Report that a set of rocks, similar to those of the lake, were observed and traced for a long distance up the valley of the Upper River; and in my Report for 1870 I have described the occurrence of like strata on the valleys of the upper waters of Bay East River. The evidences of geological age in all these cases are extremely obscure; but such as we have been able to procure, show at all events with some degree of certainty (whatever horizon may be assigned to the serpentine group) that a mass of Upper or Middle Silurian strata, corresponding with that seen at Gander Bay and some neighbouring islands, runs up the valley of the Gander, and immediately overlies the group. At one place Mr. Howley found some very obscure fossils in these latter rocks, one of which bore a resemblance to a *Petraia*, a form of very common occurrence in rocks of Upper or Middle Silurian age in New World Island. On the other hand, the black slates of Bay D'Espoir and of Long Pond on the Bay East River, which are supposed to represent the Levis formation, seem to be repeated on the north side of the granite or gabbro of Round Pond, and again at the lower end of Elnuchibeish Gospen, where a black fibrous slate passes below the massive beds of serpentine which form the hill range. These latter beds are characterised by the presence of *bronzite, picrolite*, chromic and magnetic iron. Copper and iron pyrites have been found in the chlorite slates of the group within the same regions, which although unimportant in

themselves, further than as illustrative specimens, may lead to valuable developments. The more valuable ores hitherto discovered upon this island, notably those of copper, nickel, and chromic iron, have usually been found to be closely associated with serpentinous rocks; and the presence of such rocks has frequently instigated close inspection of the ground, resulting in the discovery of satisfactory metallic indications; and I have very little doubt that were access to the interior regions as easy of accomplishment as it is to the sundry parts of the sea-coast, similar experiments would be equally successful. Indeed, the cuttings and excavations which would necessarily be made in constructing roads, would almost with certainty occasionally expose mineral deposits, and give good structural sections, which otherwise might never be observed except by mere accident.

Ingress and egress to and through all those regions is not only possible, but may be obtained with the greatest ease, by the construction of a few miles of road from Freshwater to the Gander Lake, and the establishment of a small steamer on the lake itself; which would give access at once into the interior for nearly 50 miles. Thence a road might be made to run between the two upper branches of the Gander, passing through the fertile tract and into the mineral district, to tap at the most convenient part of Division B of the Railway Survey, from which point the original alignment for the railway could be followed through the island to St. George's Bay. From such a trunk line subsidiary roads might be built to connect all or most of the available parts of the island, whether mineral or agricultural; and especially those of the river and estuary of Exploits, where a large population might be maintained as farmers, having a ready market for their surplus produce in the mining districts of Notre Dame Bay.

I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

To His Excellency
Sir John Hawley Glover, G.C.M.G.,
Governor of Newfoundland, &c.

MR. HOWLEY'S REPORT.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, *February 1st*, 1876.

SIR,—I beg to submit the following Report of my season's exploration on the Gander and Gambo Rivers in connection with the geological survey of the Island.

The instructions received from you in the month of May last directed me to proceed as soon as the season was sufficiently advanced and the navigation clear to Gander Bay, ascend the river to the Great Lake, and thence make a survey of its upper waters as far as practicable. This being accomplished, the Gambo River was also to be surveyed by effecting a portage to some part of its waters from the most convenient point on the Gander River or Lake.

Owing to the unusual quantity of field ice in Notre Dame Bay, especially on its southern side, which rendered the approach to Gander Bay out of the question, I was forced to delay my departure till the last week in June. I left St. John's in the steamer *Tiger* on the 27th, accompanied by one Indian, and arrived at Twillingate in due time. Here a small schooner was engaged to convey myself and stores to Gander Bay, which we reached on the 4th of July. At the latter place I was joined by two more Indians from Bay D'Espoir. After some little delay in packing our provisions, repairing canoes and arranging the camp equipage, I hired a fourth man (a resident of the place) to complete my crew, and started up the river on the 8th. On reaching the great lake we immediately proceeded to the mouth of the main inflowing river where our season's operations were to commence. The river being exceedingly low at this time, it became quite evident that its ascent would be a matter of no little difficulty, and that our canoes could only be availed of to a very limited extent. We accordingly prepared for a long journey on foot by leaving behind all unnecessary provisions, clothing, instruments, &c., which were secured in a strongly-built cache on an island in the river.

The ascent of the main river was long and tedious. We succeeded with much difficulty in getting our canoes, very lightly laden about 20 miles up stream, but were then compelled to abandon them and pursue the remainder of the distance entirely on foot,

carrying camps, bedding, provisions, &c., all on our backs. The survey terminated at an elevated bare ridge, 61 miles above the lake, and known to the Indians as Burnt Hill. This hill is only distant about a day's walk from Bay D'Espoir, on the southern coast. The termination of the Railway Survey line of Division B, central interior, was reached about 48 miles above the lake. Having again returned to the mouth of the river, I made the ascent of Mount Peyton, from which a set of angles was taken, and a splendid view of the surrounding country obtained. We next proceeded to the south-west arm of the lake, and commenced the survey of the South-west Gander River. After ascending this river a distance of 11 miles 58 chains, it splits into two streams, one branch, which appeared to be the principal, continuing in a south-westerly direction parallel with the main Gander River, while the other, which I have named Dead Wolf River, comes from an easterly direction. This latter was first followed to its head waters in the hope of finding an easy portage thence to the Gambo; but the river soon entered a great mountain range known as the Middle Ridge, became very narrow and tortuous, with numerous falls and cataracts, while its bed for miles was choked with boulders and huge angular fragments of granite, rendering it utterly impossible to proceed with the canoes and provisions. While surveying this branch, the heat which was every day increasing reached a climax, and was excessive in the extreme. To add to the intensity of the natural heat, a great fire was raging somewhere to the west of our position, the smoke from which for some days was occasionally almost suffocating. Fortunately a change of weather and heavy rain, on the 16th of August, extinguished the fire and greatly tempered the atmosphere.

On returning to the forks of the river it was found that our stock of provisions was all but exhausted. I was therefore obliged to dispatch one of my men back to the lake for a further supply to enable me to carry out the survey of the western branch. I had previously sent another of my men to the eastern end of the lake for the purpose of ascertaining the possibility of making a portage thence to Freshwater Bay, and if so to clear away any existing obstructions. In the meantime I pushed on with the two remaining men up the river and reached some 14 miles above the fork, when I was compelled, very reluctantly, to abandon the

survey and retreat in haste to the lake. This was caused by the entire failure of our provisions, and the non-arrival of my messenger who had been sent down to procure an additional supply. We found on our return that he had been seized with an illness resembling paralysis and was unable to walk. He had reascended the river for some distance, but finding his illness was by no means subsiding, and fearing he would be unable to reach us, he finally retraced his steps to the lake. The season was now drawing on, and as I had not yet heard from my other man as to the prospects of our getting across to Gambo, I concluded to push on to the eastern end of the lake and ascertain the character of the ground to be crossed, for myself. On my way downwards we met the man returning and were rejoiced to learn that the difficulties in the way of transit were very trifling. Starting from the extreme eastern end of Gander Lake, we made a portage of about 4 miles over a level country lately swept by fire, to a large pond called Butt's Pond, the water from which flows into Freshwater Bay where it is known as the Middle River. Our canoes were thence passed down lightly laden on this stream to within less than a mile of the salt water. The portaging of the remaining baggage was a work of considerable labour, but was accomplished without any great difficulty or delay.

We reached Freshwater Bay on the 28th of August, and lost no time in refitting for the survey of the Gambo; but the progress of our work was much interrupted by the wet, cold, and stormy weather of the month of September.

Having surveyed the two Gambo Ponds, Lower and Upper, the Riverhead Brook was first followed for a distance of 4 miles, but beyond that distance the river was found impracticable for canoe navigation. It flows along the eastern flank of the Middle Ridge Mountain Range, and for over 3 miles of its course is walled in by perpendicular cliffs which form a fearful chasm, through which the water foams and tumbles with terrific fury.

The Triton River, which is the main branch of the Gambo, was next surveyed to the forks, a distance of nearly 20 miles above the upper pond. Here it splits into two branches of small size. Neither of these being of much importance, I did not continue the survey beyond the forks, where the season's field-work terminated.

Hydrography of the Region.

The drainage of the country lying between the Great Exploits River and the eastern seaboard is mainly effected through the Gander, the Gambo, and the Terranova Rivers. Of these the Gander with its tributaries alone drains an area of little less than 4000 square miles, and is consequently equal, or nearly equal, in the volume of water discharged ultimately into the sea, with the Great Exploits River. At page 252 Report for 1871, I perceive you there estimate that the drainage of the Exploits covered an area of a little under 3000 square miles; and at page 358 Report for 1874 you put the area drained by the Gander at 2700 square miles. The surveys accomplished by myself since those dates, viz. of the upper waters of the Exploits in 1875, and the upper waters of the Gander last summer, tend to show that in both cases you have underestimated the extent of the drainage systems, which together occupy an area probably little under 8000 square miles.

The main branch of the Gander River takes its rise on the western side of the range of hills known as the Fox Ridge, from some small mountain tarns not far from the head waters of the Great Rattling Brook of the Exploits, situated in about 48° 30′ north lat., and 55° 49′ west long. Thence flowing southerly it makes a great sweep around the south-west end of the Fox Ridge, becoming gradually expanded in its course by contributions from various small tarns and rivulets, the drainage of the marshes, till reaching the base of a hill known as Burnt Hill, when its course flows generally north-easterly but with many sinuosities to its junction with the Great Lake. A little to the westward of Burnt Hill it receives a small tributary which takes its rise near Newfoundland Dog Pond on the Bay East River, and mentioned in your Report for 1870. Several other large tributaries join the river on either side between Burnt Hill and the lake. The principal of these are Maurice Lewis Brook, Nibnosseguuanjeech, Upper and Lower Gull Brooks, and Island Brook on the south side; Fox Hill Brook, M'-skeguum, Miguel's and Cooper's Brooks on the north side.

For a distance of 30 miles above the lake the river is wide and shallow with a gentle easy flowing current all the way, the banks on either side being often flat or sloping gradually upwards. Many islands or intervals occur especially at its outlet into the

lake, where a delta of about 3 miles in extent is cut up into a group of islands. A little over 30 miles, two chutes occur about a mile apart; but beyond the upper of these nearly to the end of my measurement it continues to flow gently and evenly, devoid of rapids or even of strong currents. The river was at its lowest during our visit, owing to the long continuance of great heat and dry weather; but it usually is very low during the summer months, in consequence of the absence of large ponds and lakes to act as feeders. There are occasions, however, especially in the early spring and late fall, when the river, swollen by melting snows and long continuance of heavy rains, can hardly be excelled for canoe navigation or the rafting of timber.

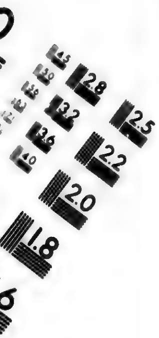
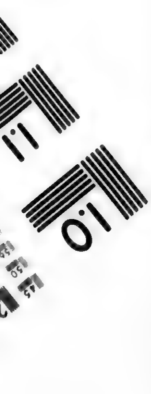
The following tabular arrangement of courses and distances ascending the river from the lake, will give a more concise idea of its general character.

TABULAR ARRANGEMENT OF COURSES AND DISTANCES.

No.	Course.	Distance	Approximate rise in Feet.	Remarks, &c.
		mls. chs.		
1	S. 48° W.	1 15	5	From point south-side entrance to main river through group of islands to point of Long Island, very gentle current.
2	S. 19° W.	5 18	15	From end of Long Island to bend of river, nearly straight; smooth current.
3	S. 60° W.	1 25	10	To another bend of river, partly confined between cliffs, where there is a deep hole of water and a rather strong current.
4	S. 21° W.	1 15	6	Nearly straight, wide and shallow.
5	S. 52° W.	1 45	7	Through islands and shoals.
6	S. 37° W.	1 0	5	Ditto ditto.
7	S. 67° W.	0 75	3	Forms a curve; Island Brook comes in about half-way on eastern side.
8	S. 21° W.	0 40	2	Straight course, gentle current.
9	S. 66° W.	1 50	9	Through group of islands.
10	S. 50° W.	1 40	9	To point of small island, Cooper's Brook comes in about half-way on west side.
11	S. 25° W.	0 35	2	Straight along main channel.
12	S. 51° W.	1 76	10	Through group of islands and shoals.
13	S. 6° W.	1 60	8	Along main channel shallow, gentle current.
14	S. 39° W.	1 0	5	Makes a curve, smooth current.
15	S. 18° E.	0 25	1	Straight; gentle current.
16	S. 63° W.	1 0	6	Forms a considerable curve.
17	S. 16° W.	1 0	5	Nearly straight, wide and shallow.
18	S. 50° W.	1 28	7	Perfectly straight along centre of channel.
19	S. 86° W.	1 55	8	Through group of islands to mouth of Lower Gull Brook.
20	N. 58° W.	2 20	20	Along centre of channel through a group of islands and over first chute, to mouth of Small Brook, strong currents and rapids.

TABULAR ARRANGEMENT OF COURSES AND DISTANCES—*continued*.

No.	Course.	Distance mls. chs.	Approximate rise in Feet.	Remarks, &c.
21	S. 57° 30′ W.	1 6	4	To foot of second chute.
22	S. 10° E.	0 45	12	Over second chute to sharp bend, rapids and strong current.
23	S. 60° W.	1 30	5	Along centre of channel, very straight.
24	S. 87° W.	0 68	4	A slight curve, gentle current, river wide and shallow.
25	S. 55° W.	0 55	4	Gentle bend, high bluff of serpentine on east side.
26	N. 40° W.	0 56	5	Straight course, gentle current.
27	S. 80° W.	0 70	6	Forms a curve, ditto.
28	N. 51° W.	0 52	5	To mouth of Miguel's Brook, ditto.
29	S. 23° W.	0 50	5	Along centre of channel, nearly straight.
30	S. 8° 30′ E.	0 26	3	Ditto ditto.
31	S. 35° W.	0 50	5	A slight curve.
32	S. 22° E.	1 12	17	Nearly straight. — Pretty strong current (31–33).
33	S. 3° W.	1 47	18	Gentle turn, serpentine cliff on right side.
34	S. 31° 30′ W.	2 24	26	Very straight, gentle current.
35	S. 16° E.	0 63	6	To mouth of Upper Gull Brook.
36	S. 31° W.	0 40	5	Slight curve.
37	S. 71° W.	0 56	8	Ditto.
38	S. 23° 30′ W.	0 45	6	Nearly straight. — Rattling strong current, but flowing very regularly (36–41).
39	S. 60° W.	0 70	10	To end of burnt woods.
40	S. 55° W.	2 20	25	Nearly straight.
41	N. 64° W.	0 30	5	To termination of railway line, Division B.
42	S. 66° W.	1 55	20	Rather crooked. M'-skeguum Brook comes in on north side, and Nibnosseguuanjeeck on south side. Indian mail route to Exploits crosses the river near the mouth of the latter.
43	S. 36° W.	0 45	5	Forms a curve.
44	S. 80° W.	0 45	6	Fox Hill Brook comes in on the north side.
45	S. 36° W.	0 68	10	Through a group of islands where there is a pretty swift current.
46	S. 64° W.	1 0	15	To sharp angle, serpentine cliff on right side, pretty strong current.
47	N. 54° W.	0 35	4	Ditto ditto.
48	S. 44° W.	1 16	18	Rather crooked, pretty strong current.
49	S. 3° W.	1 0	12	Ditto ditto.
50	S. 35° E.	1 30	20	Ditto ditto.
51	South.	1 35	23	To mouth of Maurice Lewis Brook.
52	S. 36° W.	0 60	8	Slightly curved. — Pretty strong current (52–53).
53	S. 6° E.	0 30	5	Straight curve.
54	S. 51° W.	1 20	25	To end of measurement on river, very crooked; several strong currents.
			498	Total rise on river.
55	S. 10° W.	1 20	540	To top of Burnt Hill.
		61 76	1038	Total distance and rise above lake.
			75	Height of lake above sea-level.
			1113	Total rise above high-water mark to top of Burnt Hill.

South-west Gander River.

Both branches of the South-west Gander River take their rise amongst the most elevated peaks of the great Middle Ridge, at altitudes of little less than 1000 feet above the sea. This ridge which stretches across the country from Fortune Bay to the northern shores of Bonavista Bay, forming a crescent-shaped belt of bare-topped hills, is the great watershed of the east and north-flowing rivers in this section of the country. Rising gradually from the southern coast, it attains the greatest elevation a little north of the termination of Division C Railway Survey of last year, and then rapidly falls again in its north-eastern strike. It runs out to the sea-coast between the eastern end of Gander Lake and Freshwater Bay, where it dies down to an elevation of only 150 feet, and terminates in the broken irregular country, forming the peninsula of which Cape Freels is the extreme eastern point.

The head waters of the main branch of the South-west Gander are situated in nearly the same latitude as those of the main river, but fully a degree farther east in longitude. The river flows from a lake from about 3 to 4 miles in length, known to the Indians as Little Gander Pond. Its course at first is nearly west, until it emerges from the mountain range, which it sweeps through gradually, finally assuming the general north-easterly direction, which it maintains with tolerably little divergence to its junction with the great lake at the head of the south-west arm.

Dead Wolf River rises from a small tarn in lat. 48° 39′ N., long. 54° 39′ W., nearly, and is only separated from a tributary of the Riverhead Gambo Brook by about half a mile of marsh. A little over a mile from its extreme head, it enters a lake 3 miles long, called Wengeguumjeech Gospen, or Little House Pond. Its general course thence for nearly 6 miles is a little north of west, when turning sharply to the north it forms a right angle, and at a distance of 2½ miles it bends to the north-west 1½ mile farther and joins the main branch. Several tributaries connect with both branches, coming from various directions—the only one of any importance being John Mitchell's Brook, which comes in on the eastern side, about half-way between the forks and Great Lake.

For the first nine miles of its course the South-west River is pretty wide, and when well supplied with water is good for canoe navigation. Many islands or intervals covered with beautiful soil are met with on these lower reaches, and extensive backwaters are also of frequent occurrence; but about 2 miles below the forks there are some difficult and dangerous rapids, where the river becomes confined to a narrow space by slaty cliffs on either side. The main branch above the forks is again similarly confined between high perpendicular, and sometimes overhanging cliffs, forming a canyon 3 miles long, through which the water rushes with fearful force over precipices and broken crags, in an almost uninterrupted succession of falls and chutes. Beyond this, however, to the end of my measurement, there are only a few strong rapids, and the river becomes comparatively smooth and placid.

The Dead Wolf River is extremely rugged for nearly its entire length from the forks to Wengeguumjeech, and is at times very small and insignificant.

The Gambo River.

The Gambo River is approached from the sea by Freshwater Bay, a long narrow arm of the Great Bay of Bonavista, which stretches inland some 20 miles from the open water of the latter, bearing generally south-west by west, and north-east by east. The river enters at its extreme head, its mouth being situated in lat. 48° 46′ 5″, long. 54° 12′ 32″. Two miles and three-quarters from its outlet, it expands into a long narrow lake known to the lumbermen as the First or Lower Gambo Pond. It then contracts at a place called the Straits for a little over 1 mile, and expands again into the second or Upper Gambo Pond, nearly equal in length to the first but somewhat wider. Triton River enters this lake in a bay about 3 miles from its head, the Riverhead Brook falling in at its extreme western end.

The annexed table will more clearly show the directions followed on this important river.

TABLE OF DIRECTIONS.

No.	Course.	Distance	Approximate rise in Feet.	Remarks.
		mls. chs.		
1	S. 34° W.	1 30	4	From a point on the north side of the Gambo River at its junction with the bay, to the first bend. River pretty wide.
2	S. 13° W.	1 30	6	To outlet of First Pond partly through islands, much encumbered with boulders.
3	S. 48° W.	5 35	..	Up centre of First Pond.
4	S. 62° W.	3 0	..	To head of ditto.
5	S. 44° W.	1 7	5	Through Straits to Second Pond.
6	S. 84° W.	0 35	..	To body of Second Pond.
7	S. 61° W.	2 48	..	Up centre of ditto.
8	S. 85° 30′ W.	4 47	..	To mouth of Riverhead Brook.
9	S. 73° W.	2 43	..	From No. 7 to mouth of Triton River.
10	S. 62° W.	4 10	30	Along general course of Triton River to sharp bend. River extremely tortuous.
11	S. 77° W.	5 25	38	Along general course of river.
12	S. 57° W.	1 72	15	Ditto ditto.
13	S. 36° W.	2 65	35	To forks of river, end of measurement.
		36 47	133	Total distance and rise on river.

Several minor brooks flow into the lakes from the country on either side. These are the Mint Brooks, Skimitan's Brook, Oliver's Brook, and Parsons' Brook of the Lower Pond. Pine Brook and South Brook of the Upper Pond. Rocky Brook joins the Triton River 3 miles above the outlet. Mint Brook and Parsons' Brook are the two largest and most important of these. The former, which joins the lake on the north side about a mile from the exit of the main river, rises, in close proximity to John Mitchell's Brook of the South-west Gander, and flowing eastward, passes through several large ponds. Two of these ponds, known as North Pond and Mason's Pond, lie parallel with the Gambo Ponds, and are situated between 4 and 5 miles to the northward of the latter. Parsons' Brook, which joins the Lower Pond on the south side a mile and a quarter from the head, almost meets the waters of Maccle's Pond, a tributary of the Terranova River (see Report for 1869). Its general course is about north-west. Between 2 and 3 miles from its junction with the lake it expands into a good-sized pond called Parsons' Pond.

Middle Brook, the same which was partly availed of in making the portage from the east end of the Gander Lake, flows into Freshwater Bay about 3 miles northerly from the outlet of the Gambo. Its head waters interlock with those of Hunt's Brook

(see Report for 1874, p. 355). Its general course is easterly, parallel with Mint Brook, till it reaches Butt's Pond, whence it turns sharply to the south-east and enters the salt water in a little over 2 miles. Besides Butt's Pond, there are several others on its waters, of which Square Pond and Burnt Pond are the two largest. The Gambo is a fine stream, usually accessible for canoes or boats for many miles up its course. For 2 miles above the entrance at Freshwater Bay it is wide and rapid, much encumbered with boulders and islands; but there is a good channel sufficiently deep to permit boats to pass at all seasons, while for canoe navigation or driving logs it is well adapted. The navigation of these two miles might easily be made perfect to the lower pond at a very trifling expense, by clearing away the boulders and other obstructions, and diverting the waters into one main channel. There would then be no interruption until reaching the Straits, which connect the lower and upper ponds, where a small outlay would again guide the water into one leading channel and complete the operation, rendering the river navigable for craft of a moderate size for 20 miles up its course, to the head of the upper pond. This work accomplished and a saw-mill erected at the entrance to Triton River, the lumber (which is now chiefly obtained from the valley of that stream) could be shipped and forwarded direct to the coast and to the sea. Triton River is small, but exceedingly well adapted for lumbering purposes. There are no obstructions of consequence up to the forks, and it has been ascended during the spring months by the settlers with their punts, in search of spars, for 15 miles above the lake. From the forks upwards the branches of the river become very small. The main one follows a general south-west course for some 10 or 12 miles, when it opens into a small pond called Little Gambo Pond. The upward course of the other branch is in a southerly direction for about 8 miles, within which distance it makes three small ponds, and its sources are separated from a tributary of the Terranova River by a very narrow watershed.

The Riverhead Brook, which rises among the Middle Ridge Mountains, and between the two branches of the South-west Gander, follows a nearly parallel course with the Triton River; but it is so extremely rugged as to be utterly valueless for any practical purpose.

If I may seem to have been rather prolix in thus describing the geography of the Gambo, it is because little has hitherto been known concerning it, except to the settlers in the vicinity of Freshwater Bay. I have frequently heard the Gambo confounded with the Gander River. The similarity in name and the close relationship of the two no doubt have caused this, but it will be seen by the foregoing, that although their head waters are frequently in close proximity, they are nevertheless entirely and distinctly separate watercourses.

LUMBERING AND AGRICULTURAL RESOURCES.

So much has already been written upon this head, especially in your exhaustive Report for 1874, that it would almost seem superfluous to add thereto. My observations during the past season, however, being more particularly directed to that part of the Gander country above the lake, which you had then only an opportunity of seeing and judging of from a distance, warrant me in going still further into details. In doing so I may have occasion to repeat in some measure what has already been written, but I think circumstances generally necessitate such repetition, more especially since there seems to be a disposition on the part of some individuals, and frequently by persons whose opinions are likely to be taken authoritatively, to decry every statement regarding the natural capabilities of Newfoundland in general. Notwithstanding every assertion to the contrary, there is within the immense region drained by the Gander and Gambo Rivers a vast area of country capable of being easily reclaimed, and converted from its present state of wilderness into agricultural settlement. If only one-half the almost useless labour now expended in the vain endeavour to convert the barren rocks of the sea-coast into farms and gardens was directed in a legitimate manner to the opening up and settlement of these more promising districts, a very few years would suffice to show not only the capabilities of the soil, but the advantages generally to be derived by the people from the cultivation of the land.

The country lying above the Great Lake, and forming the valleys of the two rivers, presents everywhere a gently undulating surface, rising to a moderate height in its more elevated parts, and

sloping gradually and with beautiful regularity down to the river's banks on either side. For a distance of 30 miles above the lake, and at the least 2 miles on the western side of the main, and eastern side of the south-west rivers, the country is of this character, giving a block of 30 miles long by 10 wide, or an area of 300 square miles, covered with a rich deep-yellow sandy loam. Nearly every acre of this 300 square miles is well adapted for agricultural purposes, while the whole is, or was, at one time densely timbered with magnificent pine, spruce, fir, and white birch. The islands or intervals in the rivers, especially near their outlets, are perfectly level and covered with exceedingly rich and deep alluvial soil. Many of these flats are of considerable extent, and for the most part they support a large growth of timber, while a luxuriant crop of wild grass flourishes around the banks and on the lower levels. Much of the country surrounding the Great Lake is also well adapted for settlement, and the advantages of having a frontage on this future great highway will still more enhance its value.

On ascending the main river a little over 30 miles, or to the farthest limit of the pine forest, the character of the soil and timber changes very quickly. Although the country still continues flat for a long distance, with few elevations exceeding 100 or 150 feet above the general level, the rich alluvial land with dense forest is succeeded by extensive tracts of barren and marsh, interspersed with scattered patches of wood of very inferior quality; nevertheless, there are still many hundreds of acres capable of being reclaimed, and a great portion of the remainder seems well adapted for grazing purposes, while much of the timber is sufficiently good to render it a valuable adjunct in agricultural or mining industries. Following the Dead Wolf branch of the South-west River, and entering upon the flank of the Middle Ridge, a very rugged district is met with which supports only a stunted growth of black spruce and fir. Here marshes and barrens extend over great areas, while the more elevated summits are for the most part bare, or covered scantily with scrub-bushes. Some good tamarack was observed to grow along the river banks and near the edges of the marshes. Much of the space between the head waters of the South-west Gander and the Gambo is of this description; but on crossing the ridge and falling into the valley of the

latter, it begins to improve again. The timber on the Gambo, especially in the valley of the Triton River, is very fine. Pine is abundant, and though not generally so large as that of the Gander, is of excellent quality. The white birch, spruce, and fir along the banks of the river are remarkably fine; indeed I have seldom seen finer in any part of the island. The land available for general agriculture in the valley of the Gambo is not extensive, being chiefly confined to the alluvial flats on either side of the river. These, however, are frequently richly luxuriant, as testified by the indigenous vegetation; especially in the valley of Triton River, where they are generally upwards of a mile in width, extending from the outlet into the upper pond to the forks. The land surrounding the Gambo ponds rises very abruptly from the water's edge, and although for the most part densely wooded, is much encumbered with boulders, and the sides of the hills often present bare rocky precipices. Spots of limited area, nevertheless, are to be seen here and there, which might be reclaimed, and become an important auxiliary to lumbering enterprises.

From careful examination of the forests at many different points, and particularly as regards the limits of available pine, I feel myself in a position to furnish the following estimate of the area supporting that timber, with tolerable confidence:—

	Square Miles.
Area of pine lands on the lower valley of the Gander River and north side of the lake	200
Valleys of the Main and South-west Rivers above the lake	300
Country along the south side of the Lake, and across to Freshwater Bay	200
Valley of the Gambo and Triton River, with their tributaries, about	150
Total	850

I conceive it probable that still further investigation may bring the total area up to 1000 square miles. Most, if not all the pine here referred to, is of the white variety, *Pinus strobus*, probably the most valuable species for the manufacture of lumber. I did not myself observe any other variety, but I was informed that the pitch pine, *Pinus rigida*, exists in small quantity on Parsons' Brook, one of the tributaries of the Gambo.

Enormous destruction has been effected at nearly every part of

the island from time to time by fire. Evidences of great conflagrations of very early date are occasionally encountered, which may have originated with the wild aborigines long before the days of Sebastian Cabot, or may have been occasioned by lightning, or spontaneous combustion; more probably one of the latter causes, as it is contrary to the habits or evident interests of the savage, to wilfully or carelessly destroy the forests, from which he derives his subsistence. On the other hand, the more recent destruction is in many cases clearly traceable to the most culpable neglect, on the part of trappers, lumber explorers or "*rhynders*," in omitting to extinguish their camp fires, or smoke heaps, which they had used to drive off flies. The more ancient of these conflagrations is recognisable by the present growth of a young and vigorous forest, surrounding the decayed or decaying trunks of large trees, whose charred limbs and stems remain as an indelible evidence of the manner of their destruction.

One of the most disastrous of the more recent fires happened about eight years ago. It originated near the main Gander River, about 40 miles above the lake, and then swept nearly the entire space between the two rivers, until checked by the intervention of the Great Lake, which saved the lower valley. One stripe of this fire crossed the South-west River a little above the forks, and pursuing an easterly course, ran through the country a few miles back of the southern shore of the lake, struck it at its eastern extreme, crossed to Freshwater Bay, and thence laid waste the entire northern side of Bonavista Bay. Another stripe of the same fire ran down the west side of the main branch of the Upper Gander, swept over Mount Peyton, which it laid bare, thence struck northerly, finally reaching the shores of the Bay of Exploits, where Messrs. Winsor and Vallance's saw-mill was caught in the flames and burnt to the ground.

Several fires of less magnitude have occurred since that great conflagration took place in parts of the same region, still further enlarging the burnt area, which, taking it altogether, cannot be less than 2000 square miles in extent. The value of the enormous amount of timber destroyed by these dreadful conflagrations is beyond calculation. Millions of magnificent trees, especially the spruce, fir, and birches, have disappeared or been rendered utterly useless. The pine, however, though scorched does not appear

otherwise to be much injured so long as it remains standing. I have examined hundreds of trees which, though stript of their leaves and bark, and bleached hard and white by long exposure, seem nevertheless to be in perfectly sound condition. The fact of its being so sound and thoroughly seasoned, occasioning considerable loss of weight, and rendering it so much more buoyant in the water, would, it appeared to me, greatly counterbalance any other defects it may have sustained. In conversation with some experienced lumbermen from New Brunswick, whom I met at the Gambo River, engaged in erecting a saw-mill for Mr. John Murphy, I was glad to find my opinion in this respect fully borne out; and I learnt further from the same source, that while in New Brunswick burnt pine is rendered almost useless in two or three years by a species of boring insect, the Newfoundland pine is, or appears to be, entirely free from the pest. From my own observation of numerous trees, in no one instance did I detect any injury resulting from the presence of insects, which fact ought to be appreciated by those about to engage in lumbering operations. The only objectionable feature to the utilisation of this burnt timber, is the fact of its being hard to cut or saw. This disadvantage should not, however, cause its entire rejection. While thus endeavouring to show the adaptability of this burnt pine for economic purposes, it should be particularly borne in mind that although a very great portion of it is in sound condition, it cannot be expected to remain so for a much longer period. Constant exposure to the elements must ere long cause it to decay. Most of the other forest trees, the spruces, firs, and birches, have succumbed and fallen to the ground, where they lie piled upon each other in heaps, and are fast crumbling to dust. Many noble pines also fall as the roots loose their hold in the ground, a sudden squall of wind laying them prostrate, and occasionally the effect produced by a single tree of great bulk giving way in this manner is to carry several others along with it, making a gap of several hundred yards in extent. Some thousands of fine trees must be thus lost each year, and no doubt the number is at a constantly increasing ratio. When once laid prostrate, very few years suffice to render the timber valueless. The moisture which appears to take so little effect upon the trees while standing erect, has full power over them when on the ground; it soaks into every crack and fibre, producing rapid decay, finally to rot like their fellows.

Thus an enormous amount of waste is going on and increasing annually, all or most of which might be checked and turned to account, by leasing the land judiciously as timber limits; thereby encouraging commercial enterprise and introducing capital and skilled labour.

To illustrate the probable loss of wealth caused by every year's delay, let us suppose that 3000 trees capable of yielding 1000 feet of lumber each are every year thrown down, and that three years on the ground are sufficient to render them unfit for marketable produce. In the first three years there would be 3000 trees entirely gone, and every year afterwards 3000 more, or altogether in nine years say 21,000. This would represent 21,000,000 feet of board which, valued at say 20 dollars per thousand feet, would give a total waste up to the present time of 420,000 dollars; and this probably is very far below the reality. Further, as the waste is constantly going on at an increasing ratio, it follows that in five or six years hence it will have then doubled or trebled the above amount. In order then to utilise what is still available of this burnt pine, no time should be lost, first in extending the base line commenced last year by Mr. McLeod to the southern side of Gander Lake, and secondly, in giving every facility necessary towards lumbering operations on a large scale. In a letter I had the honour of addressing to the Hon. Receiver-General in August last, from the Gander Lake, I entered pretty fully into particulars as to the character and quality of this pine, and of the country generally. I also made a suggestion that all licences or grants for lumbering purposes should, in the first instance, be confined to the burnt district, which suggestion I see no reason as yet to alter. It must be obvious from the foregoing that while the greater portion of the burnt timber is still most valuable, every year's, or even every day's delay, in turning it to account, lessens not only its quantity but its quality as an economic material, while reserving such timber for future purposes must necessarily be futile. A reservation of ten or twelve years more will render most of it utterly valueless. Reserve the growing pine, if desirable, which cannot deteriorate so long as it escapes fire, but will on the contrary increase in value and dimensions.

In reference to Mr. McLeod's base line, I was much struck while on the Gambo River with the immediate necessity of

continuing it from the Gander Lake into the Gambo country. I find by my survey that an extension of the line from the mouth of Joe's Brook, on the south side of Gander Lake, would strike across the Upper Gambo Pond at its widest part, and exactly 73 chains east from the mouth of Triton River, dividing the lumbering district of the Gambo into two nearly equal portions. Were a separate line established for the laying off of the latter, it could not be more favourably situated. The present system of lumbering as practised on the Gambo, where two large saw-mills are now in operation, and where timber is cut indiscriminately over at least 100 square miles of country, I think should at once call for interference on the part of the Government, but I leave it to yourself more fully to explain the disadvantages likely to accrue from such a mode of procedure, and more strongly to urge the application of a more legitimate system for the appropriation of all this valuable Crown property.

Geological Description.

In the following account of the geology of the region, I have given the details in section as observed on the banks of the respective rivers, or the country adjacent to these rivers; as it was found impossible to trace out the boundaries of formations with any satisfactory result through the intermediate lands. The difficulties attendant upon such a thorough investigation are manifold, and the limits of a single season are altogether insufficient to such a task, particularly when the geographical features (which must ever be the base of all geological examination) had still to be laid down. It may be seen in the geographical description I have given of the country, that much of it is covered up with drift, forest, or swamp, in which sections of the rock are but rarely exposed, and when they do come to the surface they are usually remotely apart. Then, again, all the rocks of the region are so highly metamorphosed, and the mineral characters of the various groups or formations frequently found so much to resemble one another, that it is difficult to distinguish them even in hand specimens. Under these circumstances I saw at once I should be compelled to adopt the sectional mode of examination on the rivers, even had I been supplied with a geographical map

which, as hitherto, had still to be constructed. The topography and river sections being now pretty correctly established, an approximation to the structure can be arrived at, and the difficulty of following out the details at some future time is reduced to a minimum.

Following the main Gander River for the first 30 miles above the lake, the rock exposures met with are chiefly hard greyish micaceous slates, with which are occasionally interstratified beds of greenish-grey sandstone and conglomerate. About a mile and a half from the outlet a small outcrop of these slates occurs, dipping N. 72° E.* < 50°. No exposure is then seen for a distance of 5 miles, when similar slates make their appearance in a vertical attitude, striking N. 7° E., S. 7° W. A mile and a quarter beyond this they form low cliffs on both sides of the river for a short distance. Fine-grained greenish-grey micaceous sandstones are here interstratified with the slates all vertical, and striking N. 42° E., S. 42° W. A little over a mile from this latter outcrop, a very fine bluish-grey silky-micaceous slate comes out on the left side of the river. This resembles the mica slate of the point and islands between the two arms of the lake, and is probably identical. It is much corrugated, and is intersected by numerous small quartz veins running in the strike, which is about N. 84° W. The hard grey slates are occasionally met with above this in low outcropping ledges, always vertical, and striking obliquely across the river. Four miles above Cooper's Brook, thick beds of rather coarse conglomerate are met with, overlaid by beds of hard grey sandstone, alternating with greenish arenaceous slates at the top. The pebbles of the conglomerate are chiefly of red jasper, green chert, with grains of white quartz cemented in a matrix of rather coarse greenish-grey sand. The pebbles rarely exceed the size of a rifle bullet. Irregular masses of dull white calcareous matter are not unfrequent in the rock, and several small cavities, where some such material had been weathered out, were also observed. Some of these latter cavities seemed to have contained fossils, one obscure form resembling a *Petraia* being found, while other organisms were suspected, although never sufficiently well preserved to be identified. Litho-

* All bearings are from the true meridian.

logically the rock resembles the Herring Head conglomerate, and is probably of the same horizon. At this exposure the strata are again vertical, striking N. 3° E., S. 3° W. About a mile and a half farther up, the same conglomerates again make their appearance in a small outcrop dipping N. 62° W. < 40°, and they are seen for the last time near the mouth of Lower Gull Brook, where the dip is N. 31° W. < 30°. No other exposures occur up to the first chute, where beds of greenish-grey sandstones and slates strike across the river dipping N. 52° W. < 55°. Similar rocks form the second chute nearly a mile beyond. At the latter the dip is N. 55° E. < 60°. Two intrusive dykes of a dark grey syenite cut the rocks here between the two chutes, one running N. 60° W., the other N. 15° W. They do not appear to cause any great disturbance or alteration except at their immediate contact. What the exact age of these rocks may be can only be conjectured for the present. The striking lithological resemblances, especially of the basic sandstones and conglomerates with the rocks of New World Island, and the presence of fossils although obscure, seems to indicate the horizon of the upper part of the Middle or lower part of the Upper Silurian series.

At a bend of the main river, 2¾ miles above the upper chute, at the end of the twenty-fifth course (see table of courses and distances, p. 441), a high bare bluff occurs, rising steeply from the south side of the river to a height of over 200 feet. The rocks forming this bluff present a perpendicular cliff to the river about 30 or 40 feet high, and consist at the base of a mass of incoherent serpentines and chloritic slates, confusedly combined, where the layers of deposit are only to be distinguished by some bands of an opaque white or yellow-weathering picrolite, running apparently in the planes of the bedding. The rock in some parts is reticulated by minute thread-like veins of a greenish silky asbestos. Much of it weathers a pale yellowish brown, or orange yellow on the exposed surface, but on fracture it is generally of a dull earthy dark green colour, with shades of light green here and there. Other portions of the cliff display serpentine of a dark bottle-green throughout, very incoherent, and exhibits a smooth glistening soapy surface on fracture. The top of the bluff is composed of a dark grey crystalline rock, exceedingly hard, and weathering dull white. From its remark-

able weight, this rock was supposed to contain an ore of iron disseminated through it. Stains of green carbonate of copper were observed at one place. The strike of these rocks is about north-west and south-east. Three-quarters of a mile beyond the bluff a set of dark blue chloritic slates underlaid by beds of hard grey quartzite crop out, dipping S. 25° E. < 56°. Similar slates and quartzites hold the river's bed for about a mile beyond Miguel's Brook, where a considerable exposure occurs, the dip here being N. 18° W. < 32°. About 3 miles farther up stream the serpentine rocks are again seen to form a high cliff for half a mile or more, and thence a bare yellow-weathering ridge strikes a long distance inland, in a direction about N. 73° E. The serpentines at this part are very similar to those below, but have in addition a band of a steatitic character loosely aggregated, of a slaty structure, and holding irregular strings and lumps of pale yellow-weathering picrolite. But the greater portion of the exposure consists of a dull green earthy rock in thick beds, which weathers yellowish brown, and is seamed with thin strings of asbestos, while the bedding is generally separated by small bands of picrolite, or occasionally by nearly pure serpentine varying from a quarter of an inch to an inch in thickness. These latter bands generally weather out in relief, and are of a pale blue colour on the exposed surface. The bottle-green serpentine, with the smooth glistening fracture, is also well displayed, and seems to occupy a superior position to the former. Dark blue very ferruginous chloritic slates, interstratified with dark grey fine-grained sandstones or diorites, underlie the serpentines. Some of these bands are exceedingly hard, assuming the character of grey quartzite, while both sandstones and slates are thickly impregnated with iron pyrites. About half a mile back from the river to the eastward, a hard crystalline white rock, which weathers a deep rusty red, apparently a dolomite, forms a bare ridge, and appears to surmount the whole mass. The strike of this latter can be distinguished for miles by its brick-red colour. Its exposed beds display remarkable honeycombed surfaces, where the cavities, apparently weather-worn, sink several inches into the stone. Irregular veins of milk-white quartz stand out in relief from the deeply weathered surface of the rock. The fracture exhibits the effect

of weathering for half an inch or more, the colour becoming gradually of a paler shade as it penetrates the stone, while internally the rock presents a dull white colour, streaked with grey, with occasional shades of pale yellow or green. The surface of the country here is exceedingly bare, the few stunted trees and bushes which once existed being entirely swept away by fire. While in this desolate region, I was particularly struck by the frequent occurrence of isolated level spots of sand and gravel, sometimes several hundred yards in circumference, which, from the regularity displayed in the separation of the coarser from the finer material, and the manner in which the former was arranged, might be imagined to have been effected by human agency. These were formed occasionally in almost uniform straight ridges of nearly equal breadth protruding through the sand or finer gravel, while at other times they rose in circular walls encircling the same; and in other instances the coarse material formed a curiously complicated network, the finer deposit being enclosed by the mesh-like ridges of the former.

Another small outcrop of the serpentines takes place about a mile farther on the same side of the river. Chloritic slates, diorites, and quartzites then succeed for a long distance. These are often much corrugated, and form a succession of low sharp undulations. The slates generally vary in colour from dark blue to grey and nearly black, occasionally greenish or slightly purplish, and are frequently very ferruginous. Some of these strata are arenaceous, rather compact and flaggy, while others are close-grained, have a fine slaty cleavage parallel with or slightly inclined to the bedding, and occasionally they exhibit a finely laminated and fibrous structure. Quartz veins occur in many places, running parallel with the bedding. Iron pyrites in minute specks is thickly disseminated through these latter, as well as the greater portion of the slates. The general strike is about N. 18° W., S. 18° E. Two miles beyond the termination of Division B of the Railway Survey, a mass of coarse brecciated trap strikes across the river, bearing N. 76° E., S. 76° W. Two and a half miles farther up, the serpentines again appear in considerable volume, forming a high broken cliff on the south side of the river, and exposures continue at short intervals apart for nearly 2 miles more. These rocks spread over a large area, and

are seen to cap many bare elevated ridges to the eastward of the river, the strike continuing in the same direction. In a few instances they were found to vary somewhat in character from the magnesian rocks farther down the stream, especially on some of the exposed ridges back from the river. While the dull green earthy, yellow-weathering rock forms the greater portion of the exposures, a coarsely crystalline rock of a green colour weathering rusty red, the crystals of which were supposed to be pyroxene, is associated with it. Near the apparent base of the serpentines, a set of dull white weathering bands are interstratified, some of which when broken present a soft, milk-white colour, tinged with spots of pale olive green. In texture these beds are finely granular, and they display a brisk effervescence under an acid. The green stain is probably derived from the presence of chrome, nickel, or copper. The serpentines are only separated by about 100 yards of low, marshy ground, from a ridge of coarse grey granite. Beyond the last-mentioned ridge to the termination of the measurement, the rocks are all granite. Burnt Hill is entirely of granite, and the mass strikes thence N. 12° W., S. 12° E. Farther, the features displayed in the country stretching towards the head waters of the Gander and Bay East Rivers, on the one hand, and away towards Fortune Bay, on the other, appear to indicate the continuance of an uninterrupted range of granite, or rocks of a granitic character, over a vast region. The constituents of the rock, when examined, were found to be generally an aggregate of rather coarse-grained opaque white quartz, pale flesh-coloured feldspar, and scales of blackish or brownish mica. It disintegrates freely when exposed to the action of the atmosphere; and the surfaces, particularly where fire has run, weather a dull greyish white. Large boulders and innumerable fragments of mica slate, generally of a steel-grey colour, are scattered over the surface, which probably are derived from the lower or depressed grounds, where the solid rock is concealed below an accumulation of peat bog or drift.

The relative position these mica slates hold to the serpentines, or the relation of the granite to either, was not ascertained with certainty, and requires further and more extended investigation; but the impression made by the apparent mode of its occurrence at various parts of its distribution seems to accord with the opinion

expressed in the Report for 1874, that it is intrusive; and if so, consequently may probably prove to be of later date than the Quebec group, or even perhaps contemporary of Middle Silurian. The resemblances in mineral and lithological character which obtain between the magnesian group of this region and the metamorphic rocks at other parts of the island, where the succession is better defined, is strikingly suggestive of its horizon being that of the Quebec group, which is now provisionally assumed. Nevertheless, the absence, or apparent absence, of the lower members of the Lower Silurian system involves a difficulty which at present can only be explained by want of conformity or overlapping, which unconformity, however, quite accords with the evidences afforded by the structure at Port-a-Port Bay, on the western side of the island, and that at Hare Bay, at the northern extreme. Another evidence, moreover, indirectly points towards the probable age of the serpentines, in as far as the succeeding formations appear persistently to be of a horizon somewhere intermediate between the Upper Hudson's River and the Clinton, or in other words Middle Silurian. The succession at New World and the adjacent islands, where well-defined fossils are abundant, has been described in former Reports. There, the rocks are partially or extensively altered, and are intersected by numerous intrusions of trap and granite, the intensity of the metamorphism increasing as it extends up Gander Bay, where, however, fossils, although obscure, were found. In the region under description it has already been stated that some very obscure fossils (one having much the aspect of the cast of a *Petraia*) were observed, from which it is fair to infer that those Middle Silurian strata run up the valley of the Gander, probably in some cases forming outlying detached patches, spreading over the magnesian rocks in similar relation to that seen at New World Island and in Gander Bay.

ROCKS OF THE SOUTH-WEST GANDER RIVER.

In following up the South-west Gander River from its outlet, after passing some exposures of slate, corresponding with the slates of the island and points between the west and south-west arms on the Great Lake, a conglomerate rock is met with on the bank

nearly opposite the junction of John Mitchell's Brook, which was supposed to represent the conglomerate seen previously on the main river. The next exposure is about 2 miles below the junction of Dead Wolf River with the main branch, consisting of high cliffs of dark bluish slates, which rise over the banks for nearly a mile. The exposed surfaces of these slates exhibit a fibrous texture and pearly lustre, and are characterised throughout by the presence of innumerable small drusy cavities, incrusted with oxide of iron, probably resulting from the decomposition of minute crystals of iron pyrites. Many quartz veins run through the slates, frequently following a course parallel with the bedding, and they are found to contain a mineral, supposed to be pyrrhotine or magnetic pyrites, in considerable abundance; while copper pyrites in small specks or minute strings were occasionally observable. The general dip here is for the most part easterly, the angle of inclination varying from 20° to 60°. At one place a small trap dyke, about 2 feet wide, intersects the slates, running nearly on the strike of the strata, which is apparently but slightly disturbed. Above the forks of the before-mentioned streams, these slates rise again in high perpendicular cliffs, which hold the banks of the main branch for upwards of 3 miles. At some parts of their outcrop they present a smooth and even cleavage, splitting readily into slabs, of from a quarter to 1 inch or more in thickness; others are more finely laminated, but less coherent. Some of the former appear to be well adapted for roofing and other economic purposes. Occasionally beds of hard grey sandstone are interstratified with the slates, which, with the associated beds, dip with tolerable regularity from east to S. 30° E.

On the Dead Wolf branch, about a mile above the forks, the slates dip N. 38° W. $<$ 9°. At their base, apparently passing below them conformably, are some beds of a finely micaceous grey sandstone which weathers rusty brown. This rock is much altered, assuming a gneissoid character on some occasions, but in very regular strata, varying in thickness from 1 to 6 inches, which dip in the same direction as the slates, at an angle to the horizontal of 24°. The country approaching towards Wengegu-umjeech Gospen seems chiefly to be occupied by these latter rocks, arranged generally in a series of alternating anticlinal and syn-

clinal lines, but in some parts displaying more intense disturbance. Nearing Wengeguumjeech Gospen some coarse grey granite was seen to cross the river, which rock or granitic gneiss apparently occupies the whole of the region surrounding the lake. Numerous large angular blocks and fragments of granite are strewn over the bed of the river and the lake shores, and the surface of the ground is encumbered with such in all directions.

The granite country to the south-eastward of the ridge of granite at Wengeguumjeech Gospen, which may be distinguished as the Great Middle Ridge Mountain Range, assumes very much the aspect of Laurentian, and coincides with the general run of that system as recognised on the northern side of Bonavista Bay; but the relation these highly metamorphosed rocks bear to the succeeding strata of gneissoid micaceous rocks, and the overlying slates, or the relation of the latter two to each other, is extremely difficult to unravel; and before further and more extended examination has been accomplished, the exact horizon of either must remain in abeyance. Provisionally for present convenience, the granitic country aforesaid is assumed to be Laurentian, and the micaceous sandstones and slates as of Lower Silurian age, on or near the horizon of the Quebec group, coming in contact with the lower series by dislocation and unconformity.

Between the eastern end of Gander Lake and Freshwater Bay, the land is generally of a level character, where the rock is but rarely exposed in place. A few low ledges of gneiss crop out near Butt's Pond, striking about north-east by east, south-west by west, which were supposed from the aspect of the rock and the geographical position, to be a continuation of the Laurentian strata which strike along the northern shores of Bonavista Bay. This section of the country is for the most part spread over by a deposit of fine yellow clay, while boulders and coarse gravel are strewn over the surface.

Ascending the Gambo waters, no rock exposures are met with on the lower course of the river or on the shores of the lower pond; but there is a good section displayed at the falls of Mint Brook, about half a mile above the outlet into the pond. These strata consist of finely laminated mica slate, much corrugated and contorted, with numerous quartz veins. They are of greenish or bluish colour, the surfaces smooth and of a silky texture. Some

sections are again exposed on the Upper Gambo Pond, and in the valley of the Riverhead Brook. The rocks of these sections are chiefly of an altered sandstone or quartzite, which at some parts passes almost imperceptibly into a gneiss, the metamorphism apparently increasing in intensity towards the interior of the country. Some of the beds exposed on the banks of the Riverhead Brook may be described as a dull grey quartzite. On the valley of Triton River, about a mile above the junction of Rocky Brook, a high bluff rises almost perpendicularly from the south bank of the stream. The rock of this bluff, which also extends over a large portion of the surrounding country, is of a steel-grey colour, is very micaceous, and of a slaty structure, the surfaces of the beds presenting deeply-cut depressions or wave-like undulations. The strike of the strata at the bluff is N. 66° E., S. 66° W., standing on edge vertically. Exposures are not numerous on or near the river's banks higher up the valley, but in some of the few outcrops a fibrous silky grey slate was observed, in addition to strata of like character to that at the bluff. The dip was almost invariably found to be vertical or nearly so, the lowest inclination registered being N. 70° W. $<$ 45°. The effect of great disturbance is manifested all through the region, but it may be presumed from the vast tract over which these rocks are spread, that their great extent is due to frequent repetition, being brought up again and again upon axes of sharp folds and flexures, rather than vertical thickness. It will be obvious, from the above statements, that the stratigraphical position in geological sequence of these latter rocks is still very doubtful. Provisionally, and for present convenience, I have assumed them to be of Huronian age, which the geographical situation appears to indicate; but there are differences in mineral constitution from the typical Huronian which must not be overlooked, especially in the presence of mica largely diffused, which in the normal character of the Huronian system is nearly absent altogether. Possibly they may merge into the great Laurentian system, although the general aspect differs materially from that system as displayed elsewhere, and at no very remote distance. Further and much more extended investigation, especially sectionally or in a north-west and south-east direction, are required to reveal the true structure of the entire region, which is extremely complicated from first to last.

In conclusion, I beg to inform you that the whole of the surveys, of which the above is a description, have been plotted on a scale of 1 inch to a mile, with every particular recorded.

I have the honour to be,

Your obedient servant,

JAMES P. HOWLEY.

Alexander Murray, Esq., F.G.S., &c.

CHAPTER XVII.

REPORT FOR 1877.—COMMENCEMENT OF COAST SURVEY OF NOTRE DAME BAY.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, *November 10th*, 1877.

MAY IT PLEASE YOUR EXCELLENCY,—

By special desire of the Government of the colony, the department under my direction has this year been diverted from its usual course in following up the geological investigation, in order to make a detailed geographical survey of certain parts of Notre Dame Bay, for the purpose, first, of correcting many discrepancies known to exist in the present coast charts, and secondly, to ascertain as nearly as possible the exact geographical boundaries of the lands which have been granted as mining locations. Our labours in relation to the former of these duties have been principally confined to details of the coast outline where mining is in active operation, or is likely to become so at some future time, and this work has been carefully constructed so as to connect with sundry of the most conspicuous points, which are now, or shortly will be, established by Staff-Commander Maxwell, R.N., who has commenced a general coast survey of the bay by order of the Admiralty.

With regard to laying off mining locations, I feel myself justified in referring to my Report for 1867, where suggestions for the laying off of these lands were given, which, if then attended to and acted upon, would have rendered the difficulties which now exist almost an impossibility, and would have materially furthered the progress of mining adventure. At page 134 of the Report for 1867 the following words may be found:—

"Taking Beaver Cove Head, on the east side of Beaver Cove, as a starting-point, the bearing along the coast from there to the Nipper's Islands off Nipper's Harbour is S. 60° W. from the true meridian. Taking this line as a base, a line may be drawn

astronomically N. 30° W. (or at right angles to the base) for 4 miles or more, as occasion requires, and the whole area blocked off into squares of 1 statute mile each. The coast frontage may then be registered as concessions or ranges, numbering 1, 2, 3, &c., while the intersected country will be divided into lots numbering 1, 2, 3, &c., inland. A licence of search upon this plan ought to be confined to 1 mile of frontage and 3 or more miles inland, as the case may be, and the square mile selected for grant finally, should be one of the blocks on the same concession. In cases where broken frontage occurs, special allowance might be made in the grant for deficiency of superficial area, but the licence should apply to the concession indicated only nevertheless. *A right of way to the nearest harbour should be reserved to every lot,* and the lines of road determined according to the physical character of the country. Where natural facilities for travel offer by lakes or ponds, the right of navigation in such waters should apply to all locations connected with a common harbour. To provide against probable inaccuracies in the surveys (either of the coast or inland), the headlands, or other prominent or well-marked natural features, as near as possible to the parts where the lot-lines strike the coast on the plan, should be specified whence the terminal boundary of such and such a lot and concession can be fixed, and the divisional lines be drawn blocking the country off in areas of a square mile, more or less, each; and all surveys must be made *astronomically*, as in many cases through the mineral country the local attraction is so great that the magnet is perfectly useless, and can only lead to error."

Previous to leaving St. John's, I was, by my own request, furnished with a map of plans, together with descriptions of the lands granted, by the Surveyor-General's office; but the former being laid off upon an old and incorrect coast chart, on a very small scale, gave but a vague idea of how the said lands were situated; while the wording of the latter was found in many cases almost altogether irreconcilable with the diagrams which accompanied them. For example: in these descriptions and diagrams it is rarely indicated whether the bearings given are from the true or the magnetic meridians; the latter being in most cases presumed to be meant, although, as I have often stated, the needle in this country is utterly unreliable, and in many parts is absolutely use-

less or worse than useless. Again, we are given to suppose that each mining area granted contains a square mile, which, however, in many cases is very far from being the case, as will be shown farther on; while in other cases, lots which were supposed to join, and represented as joining, are instead in reality far apart, unless the limits of each are to be extended very considerably beyond the imaginary area of a square mile. Areas are given also in those descriptions of rhombic figures as well as squares, the sides of which are equal, or measuring 1 mile each; whereas it must be obvious that in the case of a rhomboid, two of the parallel lines must exceed the mile in length to include the desired area; because figures of this kind to be of equal area with the square, must have two parallel sides extended to meet the parallels of a square upon the same base. In such cases, therefore (of which there are several), the areas are markedly deficient. For many years I have endeavoured to urge the necessity of adopting some systematic principle for laying off those and other lands, with the view of preventing eventually inextricable confusion and great public inconvenience; and now that the difficulties I foresaw are beginning to be seriously felt in the mining districts, it is surely high time that a new and improved method of conducting such surveys should be introduced, by placing all such operations in the hands of competent men.

The plan of operation which has been adopted for our season's survey, was precisely on the principle I recommended in my Report for 1867, and began at the point there indicated, viz. Beaver Cove Head. Commencement was made by establishing a true meridian by morning and evening observations of the sun for azimuth; and the latitude of the place was determined by observations at night upon Polaris. From the meridian thus established, our bearings were continued by working on the limb of a theodolite, the distances being measured by micrometer telescope, and angles were taken from each station upon all prominent and well-marked features, either on the coast or in the interior. Where the coast was inaccessible, the survey was carried through the country, and the headlands were connected by offsets or triangulation, or both. The preliminary operations were frequently repeated at or near each mining location, and the whole work was kept in connection by a continuous system of triangulation. By this means the exact

geographical position of the boundaries of each location can be described in their relation to the nearest headland, or other prominent feature, and thence along their line of bearing for the distance required.

In consequence of an injured limb, together with an ailment from which I have of late greatly suffered, I was unable personally to travel over the rugged ground which the survey necessarily was required to traverse, but having carefully superintended each operation as it proceeded, I can testify with the utmost confidence to the careful accuracy with which the whole work has been conducted by my assistant, Mr. James P. Howley, assisted by Mr. Charles Harvey, whose perseverance and devoted attention to their duties, it is impossible too highly to commend. In order to be enabled to mark the boundaries of the locations, it was necessary to plot each day's work as the survey proceeded; and this Mr. Howley did upon a scale of 4 inches to 1 mile. This draft, although only a field sketch, nevertheless well displays the correctness with which the various observations must have been taken, and the carefulness with which the details have been worked in.

The descriptions of the mining grants surveyed have been deposited in the Surveyor-General's office, and are illustrated in the tracings which accompany this Report. The tracings are taken directly from the field sketches mentioned above.

Numbers XIV. and XV., the former in Pilley's Island, the latter on Trump Island in Friday's Bay, were not surveyed. By the time we had accomplished the survey of Pilley's Island so far as to be in a position to establish the boundaries of No. XIII., the three months' charter of the vessel engaged for the service was nearly expired; besides which, the weather having become exceedingly unfavourable for field operations much delay was unavoidable, and I was consequently, although reluctantly, compelled to suspend the general survey and order the return of the schooner to her owners at St. John's. As it appeared to me to be probable, however, that a good deal of useful geological information was to be acquired by a survey and examination of Sunday Cove Island, Mr. Howley with two men were left there for that purpose. In consequence of the stormy weather which Mr. Howley had to contend with during the two first weeks of

October, this examination was less complete than it otherwise would have been; nevertheless, it has been of essential service in giving a clue to the general structure, which, when once satisfactorily ascertained, will greatly simplify the labours not only of the geologist, but also of the mineral explorer and miner. He accomplished a measurement of the entire circuit of the island, and connected in some degree the triangulation with the previous work of the season.

Since his return to St. John's, Mr. Howley has re-plotted the whole of the season's survey on a scale of 2½ inches to 1 mile, which includes the whole coast, with every bay, creek, harbour, island, and conspicuous height from Beaver Cove Head near Cape St. John, to Little Bay Head at the western extreme of Notre Dame Bay; with the exception of a small interval between Snook's Arm and Betts Cove; the south-west arm of Green Bay, which was surveyed in 1875; and the middle arm of the same which still remains to be done. Upon this sheet the triangulation is displayed in red lines from beginning to end, an inspection of which will of itself amply testify to the care and accuracy with which the whole work was performed.

Since the above was written, I have been kindly furnished by Staff-Commander Maxwell, of the Admiralty Coast Survey, with a tracing, showing the positions of certain of the principal headlands and other points, as determined by his triangulation of the Great Bay; and which also gives us data for filling up the hiatus already mentioned, between Snook's Arm and Betts Cove. The result of a comparison of the two separate and independent surveys, as regards the position of these prominent points, is most satisfactory. A tracing from the sheet shall be referred to your Excellency for approval, as soon as the map is completed, which if too late to altogether remedy the defects of such so-called surveys of licences and grants of mineral lands as have hitherto been permitted to pass unchallenged, will, if properly used, prevent the recurrence of the present confusion hereafter.

Before entering into particulars with regard to the geological detail of this region, a subject we are gradually becoming more enlightened upon, and acquiring clearer evidences, the collection of specimens obtained during this and previous years will require to be arranged and strictly examined and compared. This most

essential part of the investigation has hitherto been held somewhat in abeyance, partly from our time being almost entirely occupied in mapping and reporting upon each season's labours from year to year; but partly, and perhaps chiefly, from want of space whereon to place our material for inspection and study. This latter defect being now remedied, by a small addition which has been added to this building, by order of the Government, I shall exercise my best endeavours to have the whole collection in such order during the present winter months, as to serve our own purposes for further study, and to be of interest or instruction to all persons who may be inclined to visit and inspect the museum.

In conclusion, I cannot refrain from expressing to your Excellency my regret that I was provided neither with means nor authority to form a special collection of geological, mineral, and other specimens, for the purpose of representing the resources of Newfoundland at the approaching great International Exhibition to be held at Paris; as I feel confident that a display could be made which would draw attention from the European public to the colony, and be a proof of its capabilities, which have hitherto been unknown or ignored.

I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

To His Excellency Sir John Hawley Glover, G.C.M.G.,
Governor of Newfoundland, &c., St. John's.

APPENDIX.

SINCE the map of the survey has been completed on a scale of 2½ inches to 1 mile, it has been discovered that a base line, bearing exactly parallel with the general trend of the coast, can be drawn passing over or close to some of the most conspicuous fixed points of the triangulation. This line is drawn from Captain Maxwell's station on Shoe Cove Head at the eastern extreme of the survey, to Hammer Head, over Rogue's Harbour,

passing within a few chains of the cairn erected on Betts Head. In its western extension the same line strikes a fixed point on the extreme west angle at the entrance to the north-west arm of Green Bay. The bearing of this base line is N. 58° E., S. 58° W., and I should strongly recommend that the side lines of all the mining grants should be drawn at right angles to that course; that is to say, N. 32° W., S. 32° E., from the true meridian. This direction slightly alters the descriptions I gave on the tracings from the field sketches, where the bearings of the side lines are N. 34° W., S. 34° E.; but while it in no degree affects the interests of proprietors of grants, such a plan will be found of inestimable value for laying off lands in future, which would all be drawn upon parallel lines. It would be, moreover, most highly recommendable that such a base line should be actually run by survey, and marked from end to end by cairns, posts, or painted cliffs; by which means the relative position of any part inland could be readily determined.

The Tilt Cove locations, represented on the new map in *red* lines, are according to the original descriptions. The *blue* lines are drawn to show the effect which would be produced by making the lots conform with the other lots, and on parallel lines.

ALEXANDER MURRAY.

CHAPTER XVIII.

REPORT FOR 1878.—CONTINUATION OF COAST SURVEY OF NOTRE DAME BAY—EXAMINATION OF NORTH SHORE OF CONCEPTION BAY—MINING, &c.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, *January* 27*th*, 1879.

MAY IT PLEASE YOUR EXCELLENCY,—

In my Report upon the proceedings of the Geological Survey, for the year 1877, I had the honour to inform your Excellency that the duties of the department had been diverted from the usual course of investigation, and were almost exclusively directed towards making a coast survey of Notre Dame Bay. During the year 1877 the survey included all the details of the northern shore of the Great Bay from Beaver Cove Head to the entrance of the south-west arm of Green Bay; also of the western, middle, and southern arms of Notre Dame Bay, terminating at Little Bay Head, the northern point of Little Bay. In the fall of the same year Mr. Howley surveyed the entire coast of Sunday Cove Island.

The year just passed (1878) has also been chiefly devoted to a continuance of the same service, by desire of the Government, and the survey has now been extended with all the details of the coast, and a large proportion of the numerous islands as far as Badger Bay.

During the early part of the season (1878) the middle and south-west arms of Green Bay, which hitherto had been omitted, or only partially sketched in, were surveyed with every detail; and while in that locality our time was largely occupied in laying off mineral and agricultural lands, by special request of the Government; some description of which will be found farther on.

The term Green Bay is frequently, indeed always locally, applied to the whole of the great bay of Notre Dame; but more properly, and to avoid confusion in geographical description, is, or

ought to be, limited to the great inlet which leaves the great body of the bay, between Rogue's Harbour and Green Bay Island, and penetrates for many miles into the mainland. This great inlet may be described as consisting of Green Bay proper, the north-west, middle, and south-west arms; the latter of which is but an extension of the former of minor width, while the two former cut into the land at right angles or obliquely to the northern shore. All these arms have been surveyed, and are now laid down upon the general MS. map; but it was to the south-west arm that our attention was more particularly called, in consequence of the mineral indications presented there, which have since begun to be developed, with every prospect of forming a nucleus for a great mining industry.

Description of South-west Arm.

A line drawn from the eastern head of Rogue's Harbour to the channel of Green Bay Island will nearly represent a true meridian. From about mid-channel on this line, which is about 3½ miles long, a bearing from the meridian of S. 62° W., 7¼ miles, will reach the western head of Middle Arm. The western point of North-west Arm is a little under 3 miles north-east from this point, whence the inlet falls back into the land northerly for about 2 miles, where a fine stream falls in from the north. Safe and land-locked harbours can be made on either side of the North-west Arm; and Jackson's Cove, immediately opposite on the south shore, is a good anchorage, especially for small vessels. Eastward from the North-west Arm, and between it and Rogue's Harbour, is Stocking Harbour, which affords excellent shelter, but is chiefly adapted for the smaller class of vessels.

The Middle Arm is a wedge-shaped inlet, lying nearly due east and west, about 3 miles long; which being open to easterly gales is not favourably situated for harbours; but a good anchorage in ordinary weather can be found on the north side near the head. At the extreme head a wide but very shallow lagoon is enclosed within low sandy points, the bar between which is nearly dry at low water. A fine stream falls into this lagoon at its extreme western end.

Between the meridional line from Rogue's Harbour to Green

Bay Island channel, and another meridional line from the western head of Middle Arm to Birchy Head, about a mile and a half westward from Jackson's Cove, contains Green Bay proper. The latter line, which also forms the entrance to South-west Arm, is under a mile in length, whence the inlet stretches in a very straight course for about 7 miles south-westerly, with a breadth varying from a mile to a mile and a half, where it bends to the southward round Mansfield Point. The Rattling Brook falls in at the north-west angle of the arm, and is distant from Mansfield Point about a mile and a half. The bearing from Mansfield Point to King's Point, near the extreme head of the arm, is S. 32° W., a little over 2½ miles; but the main body of the arm lies nearly due north and south. Immediately south of the Rattling Brook the coast-line bends round and forms an open cove, at the southern angle of which another fine stream falls in from the westward. The coast then, on the west side of the arm, runs with a few gentle sweeps nearly due south to King's Point. The eastern coast of the arm from Mansfield Point curves gently inwards to Conglomerate Point, where the width from shore to shore is little over three-quarters of a mile, and thence sweeping easterly about half a mile, meets the outlet of the so-called South Brook, where the width to King's Point is 1 mile 23 chains. From the mouth of South Brook the coast runs south-westerly in nearly a straight line for about 1 mile 28 chains; beyond which it bears off westerly for nearly half a mile; then northerly for about the same distance, and thence with a few bends easterly to King's Point, forming a fine cove.

In common with most of the great fiords, the country is densely wooded on both sides of the South-west Arm, and affords a pleasing contrast in its landscape scenery to the bleak and desolate shores of the Great Bay. The northern shore rises in bold rocky precipices, sometimes of great height, over which the sides of the hills are clothed with a dense green foliage nearly to the extreme summits, which are bare, or only scantily covered by grey moss. On the south side the shore usually presents a cliff, less high and more broken than on the north side, while the land beyond swells into a series of rounded hills and ridges, densely covered with forest, except where here and there a landslip, at some of the steeper parts, has laid the rock bare. Farther up the arm above

Mansfield Point, the scenery changes from the hitherto abrupt and mountainous character to that of a gently undulating plain, densely covered by a stout growth of mixed timber on both sides; and finally, after rounding King's Point, a land-locked cove is entered, surrounded by an extensive area of level land supporting a splendid growth of the ordinary forest trees.

To any one in search of the picturesque, this great inlet has many rare attractions, in the ever-varying outline, and diversified scenery it presents on all sides. Bounded on the north side by a succession of lofty and nearly vertical cliffs of variegated rock, standing out in bold contrast from the bright green of the woods above; through which and above all the hoary peaks and extreme summits of the hills are occasionally seen to peer;—on the south side the gently swelling hills and valleys richly carpeted by a luxurious growth of mixed forest timber: and finally at the upper arm, the extensive soft green plain, suggestive of cornfields and farm lands, with the sharply-cut outline of the distant mountains which form the background, all combine to give a succession of landscapes an artist might revel in, and scenes to charm the tourist or traveller.

The cove inside of King's Point (which for convenience we shall call King's Cove), although limited in extent, is nearly perfect as a harbour in every respect. The northern half, which includes an area of about 4½ acres, is perfectly sheltered from all winds, and the soundings and holding ground are all that could be desired. In the little vessel that I was on board of there, we dropped our anchor in 6 fathoms, within 20 fathoms of the beach, which is of sand. The southern half, although exposed to the northerly strip of the upper arm, is nevertheless a secure anchorage, as the heavy seas that roll into the outer arm with easterly gales are effectually broken at Mansfield Point.

Copper mining being now nearly established as a settled industry in the South-west Arm, the importance and value of King's Cove cannot be overrated; and that, not only as the best and securest of harbours for vessels bound to or from the mines, but as the very best terminus for a road or railroad, which will connect the eastern and western shores of the island. Although anchorage can be obtained at Yellowfox Cove, and at several parts near the south shore of the lower arm, in moderate weather,

these in no case are worthy of being recognised as harbours, being all more or less insecure in stormy weather, particularly with easterly winds. The depth of the water in the middle of the arm below Mansfield Point is enormous, and soundings have been had at many parts within a hundred yards of the south shore of upwards of 90 fathoms. Above Mansfield Point the water gradually shallows; the lead carrying from 12 to 10, and finally to 6 fathoms, approaching and entering King's Cove. During the season, Mr. Charles Harvey, guided by instructions from me, as to the route to be followed, surveyed a line for a road from King's Cove to Bay of Islands, which passes over a level, and in many cases a fertile country, nearly the whole distance; crossing the central Carboniferous trough about its widest part, the whole measured distance being about 100 miles.

In my Report for the year 1865 I attempted to draw attention to the facilities that exist for communication between the eastern and western shores, by the natural depressions which intersect the island *between Hall's Bay* and the Bay of Islands; and at the same time pointed out the *probable existence of workable coal in the region surrounding the northern end of the Grand Pond.* I have also repeatedly represented that, in consequence of the surface of the ground being thickly covered by drift and dense vegetation, outcrops of the rock were rarely to be seen, or where seen at all, only to a very limited extent, it would therefore be advisable to have the area known to be spread over by rocks of Carboniferous age, tested for coal with the boring rod. This experimental operation is now imperatively called for, as much of the future progress of the country will depend upon the result. That the rocks which occupy the region in question are, as represented in my geological map, of Carboniferous age, there is no doubt whatever; and that there is *Coal* associated with these rocks is also perfectly well known; but as the mineral, so far as my experience goes, only shows itself in very thin irregular seams, varying from 3 to 17 inches in thickness, or in broken fragments among the débris along the shores, its importance as an economic product cannot be proved without actual experiment.

No one who has seen the country through which Mr. Harvey's survey passes, can hesitate to pronounce much of it as admirably adapted for settlement, while the forest around is still capable of

yielding abundance of good timber, notwithstanding the reckless destruction to which a large proportion of it has been exposed; and in addition to these advantages, should coal seams of workable thickness be met with in the central Carboniferous trough, with copper and lead mines in operation on each side of the island, *the construction of a railroad* to connect all the varied industries that will be called into existence, becomes a paramount necessity.

In consideration of these views, I feel constrained to urge upon the Executive Government the necessity of extreme caution as to the disposal of these lands, either as grants or licences, as the acquisition of such property by persons interested only in making profitable speculation will assuredly retard the general development so much to be desired. In accordance with instructions I received at St. John's, I laid off three settlement lots, intended to contain an area of 100 acres each, but which, in consequence of broken frontage, only contain 272 acres altogether. These were laid off from a base line across King's Cove, bearing from King's Point S. 45° W. (true), 48 chains. This base was divided into three equal parts of 16 chains, whence divisional lines were drawn at right angles for the required distance inland. Excluding the portions which lie in the waters of the cove, occasioned by the irregularity of frontage, the lots, which are marked and picketed on the ground, contain respectively 89, 83, and 100 acres, nearly all of which is level, heavily timbered, excellent agricultural land, with beautiful streams of water intersecting, and numerous apparently perennial springs. As there is an extensive back country capable of being reclaimed, between King's Cove and Indian Brook, and much of the land on both sides of the arm above Rattling Brook and Mansfield Point might be profitably brought into cultivation, I should recommend that these latter tracts be laid off for settlement purposes, while the whole of the 272 acres laid off by me should be reserved as a *town plot* and subdivided into building lots, of not more than one square acre each.

Under such circumstances, and with the prospect of a large mining population to supply with produce, the settlement of this country, especially along the line of road, may be considered as assured, and from what has been stated it will be obvious that King's Cove is probably destined to become an important

terminus, particularly should a railroad be resolved upon, for which it is in all respects admirably situated. Should seams of coal be discovered by the boring rod in the Grand Pond region, of sufficient thickness to be profitably worked, I conceive that a railroad will be found the best, and in the long run the most economical means of bringing the various industries into connected operation; and even should the central coal basin prove unproductive, there is still the field of St. George's Bay to be tested, where I have reason to believe a few seams exist well worthy of a trial; whence the mineral could easily be transported to the terminus at the Bay of Islands by steamers; while at the same time the agricultural and horticultural produce of that fertile region would be conveyed by the same means.

In the meantime the large and rapidly increasing mining population, which in Notre Dame Bay at the present time amounts to about 5000, and probably by the year 1884 will be 20,000, are entirely supplied with all the necessaries of life, as well as a large amount of lumber for building, from abroad; all of which might be produced in the country close by, and particularly along the line of road across the island, so that it must clearly be of the first importance to the enterprising capitalists so largely interested in mining adventure, to forward the readiest and best means of communication without delay; and it is to them rather than any other body that we must look to carry out a scheme which eventually must result in enormous benefit to the colony at large. I believe that data could be obtained to show that the cost of freight alone to the mining proprietors, under the present system, would in a few years be nearly sufficient to cover the expense of building a railway on the line already indicated, without taking into consideration the inconvenience and risk that would be avoided by its means when once established and in working order.

Mineral Lands.

In order to lay down the boundary lines of certain mineral grants, I re-surveyed the reach of South-west Arm between Birchy Head and Mansfield Point, marking and picketing the dividing lines of each lot, from the coast, as nearly as possible to accord

with the descriptions furnished by the Surveyor-General's office. Of these lots there are three, of which two are adjacent, the divisional line running from the Naked Man rock due south magnetic, or S. 33° 30′ E. from the true meridian one mile. The eastern boundary of the third location comes to the shore a little way inside or west of Birchy Head, and was marked by posts and pickets so as to embrace an equal area with the others of one square mile of surface. A plan with descriptions of those locations was furnished to the Executive in September last.

While I was thus engaged, Mr. Howley proceeded with the coast survey south of Little Bay Head. An account of his labours will be found appended, by which it will be seen, that during the last two seasons, the geological survey has furnished data for a reliable map of the whole coast of Notre Dame Bay from Shoe Cove, near Cape St. John, to Badger Bay on its southern side, including many of the islands; which work has since been protracted on a scale of $2\frac{1}{2}$ inches to 1 mile. With such a map, I can see no reason why the system I recommended eleven years ago for subdividing the land for licences and grants should not now be adopted; the want of which has already occasioned so much confusion and litigation. It is true that the evil has extended so far that discrepancies and irregularities exist which can never hereafter be remedied; but it is still possible to block off unoccupied or unclaimed lands, in such a fashion as to prevent confusion hereafter. For instance;—suppose the region between Notre Dame Bay and the Exploits River to be all unoccupied ground; let the whole area be blocked off upon the map in single square miles; the lots ranging from north to south to be marked by letters A B C, &c., while from east to west they will be numbered 1, 2, 3, &c. An applicant for a licence of search upon such a plan would then indicate the ground he desired to examine, by applying for lot A 1, A 2, A 3, and so on, instead of producing a scrap of paper with some unintelligible strokes scrawled over it, which professed to be, and have hitherto been received, as descriptions of localities. The lessee would then have the privilege, as before, of selecting one out of the three square miles as a grant; while the Government on one hand, and the lessee on the other, would have no difficulty in determining the exact position of the respective lots on the natural surface.

For the present, I consider it advisable to abstain from going into details of structure, distribution, mineral and lithological characters, as regards the metamorphic rocks of the region until more thoroughly investigated. The subject is one of much interest, but is surrounded by many difficulties, some of which are so formidable that it would be hazardous to express ve., confident opinions before all the circumstances of the case are fully studied out. The *general* structure and distribution of the formations as given in former Reports, and illustrated on my small-scale geological map, I have hitherto found no occasion to materially alter, although as every year produces some new facts relating to one or other of these formations, a certain modification of former views may eventually be required.

As there will probably be a great demand for information regarding the mining regions hereafter, I beg to suggest that the map of Notre Dame Bay, as laid down by the geological survey on a scale of 1 inch to 1 mile, should be lithographed and published without delay.

I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

To His Excellency Sir John H. Glover, G.C.M.G.,
Governor of Newfoundland, &c., St. John's.

REPORT OF J. P. HOWLEY.

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, *February 28th*, 1879.

SIR,—Early last spring and previous to setting out on our usual field labours, the Government requested that I should proceed to Conception Bay to examine the north shore thereof, the reported existence of copper at some parts of which having given rise to the supposition that deposits of this and other mineral economic substances might be found in available quantities. On my return from this expedition I furnished you with the following Report for the information of the Government:—

GEOLOGICAL SURVEY OFFICE,
ST. JOHN'S, *May 20th*, 1878.

SIR,—In compliance with the desire of the Government, I proceeded across Conception Bay on the 4th instant, to make an examination of that part of its north shore included in the district of Bay-de-Verde. After a short detention at Carbonear, I started on Monday the 6th for Northern Bay, which was reached early the same morning. This being the most central settlement on the shore, and conveniently situated for investigating the facts regarding the rumoured existence of copper ore, was selected as my place of residence for the time being.

From Northern Bay the examination of the country up and down the shore, as well as inland, was conducted as far as was deemed necessary. Bay-de-Verde proper was not visited, my investigation in that direction terminating at Caplin Cove, situated within 9 miles of the former locality. The aspect of the country generally towards the extremity of the peninsula did not warrant my proceeding farther, more especially as you had long previously made a special examination of that portion of the coast. The general character of the rocks met with throughout the region bears so striking a lithological resemblance to those in the neighbourhood of St. John's, that there can be little hesitation in classing them as Huronian. At Carbonear, and eastward along the road, slates of a bluish-grey colour, fine and even in texture, and cleaving into irregular oblong fragments, are met with. These slates at first occupy a considerable strip of country, spreading out in a series of synclinal and anticlinal folds, lower measures being occasionally brought to the surface on the axis of the latter. The outer points of the coast eastward are occupied chiefly by these slates as far as Flambro Head. At Western and Northern Bays in particular there is a considerable thickness displayed. They would appear to be the equivalents of division *d* of your Huronian section.* Resting upon these slates in regular sequence, and forming a series of elevated ridges inland, are seen the greenish-grey Signal Hill sandstones, division *e*, of section, which come out to the shor in great force at the head of Northern Bay, where they form perpendicular cliffs on either side of the harbour. Thence they strike along shore and seem to run out between Flambro Head and

* See Report for 1868.

Caplin Cove. At the latter place the red sandstones, division *f*, come in, occupying the coast towards Bay-de-Verde and beyond, forming also the island of Baccalieu in their eastern extension. From Flambro Head they strike inland, sweeping across the peninsula, and exhibit themselves along the southern shore of Trinity Bay for a considerable distance. They crop out along the roadside in several places, and are seen to form a high bluff raised considerably above the general level, at about a mile back from the head of Northern Bay. From hence they trend north-westerly across the country, receding rapidly from the shore. I have been informed that the red conglomerates, division *g*, of section, are met with about half-way across the peninsula, probably in the axis of one of the many synclinal depressions. The general dip of the strata all along the coast varies from N. 65° W., to N. 5° W. magnetic, the average angle of inclination being about 32°. This inclination invariably increases inland and ranges from $<20^{\circ}$ to $<50^{\circ}$.

It will be seen, by reference to your Huronian section in the Report for 1868, that with the exception of the lower divisions (*a*, *b*, and *c*), all or nearly all the formation as there described is represented here. No strata newer than Huronian were anywhere met with, and should such have at any time existed, they have long since been denuded. Were any portion left by an older denudation, the abrading action of ice in more modern times, which is everywhere apparent, would readily account for their total disappearance. This ice action is well displayed along the entire coast, not only in the rounded and grooved outline of the hill ranges, but also in several of the more extensive valleys, many of which contain glacial moraines. The till and boulder clays form deep deposits in all those lower levels, and *roche moutonnée* is exhibited in the valley extending inland from Salmon Cove. The surface of the rocks wherever exposed are smoothly worn and grooved, the general direction of the grooves corresponding with that of the valleys bearing about east and west magnetic.

The occurrence of copper pyrites at Northern Bay having recently drawn much attention to the place, a great part of my time was spent in the examination of that locality. The ore was found to be confined principally to the slates of division *d*, and did not seem to penetrate to any extent into the sandstones of division *e*, which come immediately in front of the slates, and form the cliff

at the head of the harbour. Numerous small fissures or irregular cracks are seen to intersect the face of the cliffs, probably chiefly due to shrinkage, or some slight displacement; but the comparatively undisturbed condition of the strata does not point to any great removal from its normal position. At one place four of these cracks were observed to contain thin strings of copper pyrites, most of which had become decomposed, and occasioned coatings of the green and blue carbonates of copper along the edges of the cracks. Much of the cliff has fallen from time to time, and usually having given way along the lines of these fissures, large surfaces are now exposed so stained. This circumstance has led inexperienced persons to imagine that such indicate valuable deposits of the mineral. A little farther out on the north side of the harbour similar indications were observed, and at one place a thin wedge-shaped layer of soft killas slate was seen to contain little nests and bunches of ore, while a quartz vein intersecting the same also contained little nests and strings of copper pyrites. On the south side of the harbour one small gash vein occurs in which a small quantity of copper and iron pyrites were also observed. Excepting in the above-mentioned instances, I have nowhere seen, nor heard of, any metallic indications worthy of notice along the whole coast, further than the occasional presence of oxide of manganese. This latter mineral is frequently indicated by the roadside, and on some of the more slaty portions of the cliffs, by films or coatings of the black oxide formed on the exterior surfaces of the slates, and many of the superficial boulders scattered over the country. In the vicinity of Carbonear small quantities of wad or bog manganese were observed in some of the drier peaty portions of the surface soil.

Among the slates of division *d*, more especially in the immediate vicinity of Carbonear, tolerably good slates are sometimes found, which answer the purpose of covering drains, sewers, &c., and are admirably adapted for the construction of stone walls and bridge abutments. The finer-grained portions of these slates (which are all more or less arenaceous and have a tendency to cleave into oblong fragments), when not too hard, make very good whetstones. Specimens of the latter may be had in abundance on the beach at Carbonear amongst the loose shingle.

The green and red sandstones of divisions *e* and *f*, which spread

over so large an area of the country, will be found here as elsewhere to furnish an unlimited supply of building material, such as that now so much used in St. John's for house foundations, &c.; but unless a local demand should spring up, I fear it can never become of much importance as an element of wealth.

Agriculture worthy of the name can be said to have no real existence. The soil, which is for the most part thin and poor, is encumbered with such an enormous accumulation of boulders, that the labour of rendering it at all fit for cultivation is almost incredible. Nevertheless the industry and perseverance of the inhabitants, which is worthy of the highest commendation, has succeeded in accomplishing this, and in each settlement there is a sufficient amount cleared to furnish a supply of potatoes and other vegetables for the wants of the people, and in some places sufficient hay is raised for the maintenance of a few head of cattle. It is, however, to be regretted that so much toil and genuine hard labour could not be directed to localities where the land might be expected to yield a more remunerative return.

Sheep raising might be made a source of profit and independence to many of the inhabitants, but it would be of course necessary in the first place to exterminate the useless half-starved wolfish curs which abound throughout the district, and then to introduce a much improved breed of sheep.

Timber of all kinds is now becoming very scarce, the greater portion of what had formerly existed having been destroyed by fires. In many localities the inhabitants are obliged to go long distances to procure a supply of firewood, and still farther for timber suitable for house and boat building. This latter will in a few years be exhausted; even now those who have craft large enough find it more convenient to go to Random Sound in Trinity Bay for such timber.

The want of good harbours on this shore is severely felt. Nowhere is there a creek or cove in which a craft of fifty tons burthen can moor in safety, and it is only when the winds are off shore that any attempt at landing can be made in most places. In Northern Bay, which is one of the deepest indentations, every fishing stage was swept away during the past winter. Instances not unfrequently occur in the fall of the year, when boats returning from St. John's with supplies, are compelled from stress of weather

to run for Carbonear or Harbour Grace, where weeks sometimes elapse before they can again approach the shore to land their cargoes.

In conclusion, I would add that as the cultivation of the land (such as it is) appears to be the only auxiliary to the fisheries, its encouragement is very desirable in order to enable the inhabitants to maintain themselves in some degree of comfort and independence.

I have the honour to be, Sir,

Your obedient servant,

JAMES P. HOWLEY.

To Alexander Murray, Esq., C.M.G., F.G.S.,
Director Geological Survey.

INTRODUCTION TO GENERAL REPORT.

In the month of June last I left St. John's in company with yourself and party for Notre Dame Bay, to continue the trigonometrical survey of the coast-line commenced last year. But before entering upon the principal portion of the work it was necessary to revisit Green Bay, in order to complete the surveys of the Middle Arm, and the upper portion of the south-west arm of that bay, which unavoidably were left unaccomplished last year. This work concluded, we next proceeded to Little Bay to resume the survey at the headland of that name. After establishing a true meridian line at Wild Bight, Little Bay, and fixing the position of Little Bay Head by a series of triangles, the survey was thence continued along the coast without intermission to the eastern head of Badger Bay. This extensive portion of the bay, which, besides many minor arms and creeks, includes the following important inlets, viz. Little Bay, Hall's Bay, Rabbit's Arm, Sop's Arm, and Badger Bay; all of which were instrumentally surveyed in detail, by continuous measured lines from point to point of the shore, and a regular connected system of triangulation. Sunday Cove Island partly surveyed last year, Pilley's Island, and a great portion of Triton Island were also included. The latter part of the work, especially in the neighbourhood of these great islands, was of a

very intricate character, owing to the many narrow crooked channels studded with islands on every side, which involved a considerably increased amount of instrumental work. I took occasion while in this neighbourhood of sounding the depths of water in several of these channels, with a view to ascertaining whether navigation was practicable for large craft between the islands and the mainland. To the southward of Pilley's Island it proved to be perfectly feasible though rather intricate; but in Sunday Cove Tickle there is a shallow bar extending across at its narrowest part, which would not admit of craft drawing over 6 feet of water passing through at any time.

The discrepancies of the old coast chart, so frequently alluded to, were at some parts more palpable than any hitherto met with. The defects in the general outline of the coast, and in the positions of the principal headlands, were less obvious than in the details of the arms and bays. These latter were invariably exaggerated both in length and breadth, while some important localities were placed several miles out of their true positions. In other cases deep indentations were merely represented by a slight curve in the shore, while several islands and rocks were entirely omitted. Grave errors were also detected in the soundings, which have heretofore deterred vessels from approaching the narrow tickles south of Pilley's Island. Depths of 16, 21, and 22 fathoms were found where the chart represents but 2, and from 5 to 11 fathoms in places barred off as inaccessible. In one case a dangerous rock is placed upon the chart, where careful soundings, which were borne out by the testimony of the settlers in the vicinity, failed in finding any such obstruction.

The inutility of such a map, either for the purposes of navigation, for the representation of geological structure, or as a base for laying off mineral and agricultural lands must be quite obvious. Its adoption hitherto for the latter purpose has led to much confusion and been the cause of great annoyance and inconvenience to the Government, by giving rise to disputes in reference to boundaries of mineral locations. Already the map of last season's work has been found serviceable in several instances to rectify some of these errors. Should our mining development continue to increase at its present rate, the value and importance of a correct map cannot, I think, fail to be generally recognised.

The principal purpose for which this survey of Notre Dame Bay was undertaken, having for its object the correct delineation of the coast-line, whereon the numerous mining licences and grants could be properly laid down, it became absolutely necessary to devote all my time and attention to the topographical portion of the work. It was consequently out of my power, especially in such a complicated region, to bestow on the details of geological structure that degree of careful study which the subject at all times demands. Many valuable facts were, however, observed and noted, which may be the means of throwing some light upon the problem not yet satisfactorily determined regarding the exact horizon of the cupriferous formation.

The discovery of fossils (*Graptolites*) during the season, in strata of black shale, so intimately connected with the series, is a matter of considerable interest, and may lead upon further investigation to very important structural determination of facts. As regards the metalliferous deposits, the opening of several new mines will afford opportunities of more minute investigation into their various characteristics. Although having much in common, there are nevertheless in many instances certain peculiarities not only in the manner of deposition, but also in the character of the ores, which must not be overlooked. To those who are interested in mineral development, a thorough knowledge of these facts may prove of essential service as a guide to future exploration and successful mining; while to a great extent the expenditure of much capital upon unprofitable locations may be avoided.

Before venturing to speculate upon what may or may not be the precise geological structure of the rocks of the region in question, or giving an account of their mineral character as displayed at various parts of their distribution, much more minute and extended investigation will be required; and carefully measured sections must be drawn to illustrate the relative details and manifold disturbances by which they have been effected.

I shall therefore confine myself for the present to a general description of the geographical features so far as the work has progressed, adding any information of an interesting character as I proceed, especially in relation to the various mining localities.

Geographical Features.

The north shore of Notre Dame Bay extends in a pretty straight line and on a general bearing from the true meridian about S. 54° W., taking the South Bill of Cape St. John as the starting-point. The course indicated above, after crossing over the projecting points of land in the first half of the distance, runs out into the water at Betts Cove Head, and again strikes the land at the southern point of the middle arm of Green Bay, where it terminates in a total distance of 30½ miles. Proceeding westward from Cape St. John, Shoe Cove, a wide open bight, is the first indentation met with. It has no harbour, affords but little shelter to craft of any size, and is only resorted to in the summer months by the fishing boats from various parts of the bay, whose crews are engaged in prosecuting their calling on the banks and shoals lying off the cape. There is little or no soil about Shoe Cove, the character of the surrounding country being elevated and barren in the extreme; consequently the few permanent residents live almost exclusively by fishing during summer, and seal hunting in the winter months. Lofty mural cliffs bound the coast between Shoe Cove and Cape St. John, presenting a bold front to the ocean, which at times beats against them with such terrific violence that there is no venturing within miles of the land. Beaver Cove, a small insignificant fishing station, is situated 2½ miles west of Shoe Cove. A little over a mile farther west, or just 8 miles in a direct line from the South Bill, Tilt Cove is reached, the locality of the well-known Union mine. It is a narrow nook walled in by high vertical cliffs, which, on its eastern side, rise abruptly to a height of nearly 500 feet. A pretty sheet of fresh water, Winser Lake, surrounded by an amphitheatre of hills, lies just behind the narrow beach at the head of the cove, which less than 3 chains in width separates it from the salt water. The mine bluff, a low-rounded, bare-topped hill, whose exceedingly ferruginous brown-coloured surface at once betokens the presence of mineral matter, is situated on the western side near the foot of the lake. Honey-combed by numerous drifts and stopes, and open cuttings on the top in the process of mining the ores, the bluff has undergone considerable alteration since the opening up of the mine. Directly in rear of this bluff, and attaining a height of 516 feet above high-

water mark, is Murray's Look-out, one of the most prominent summits in the immediate neighbourhood of Tilt Cove. Bennett's Look-out rises on the opposite or eastern side of the pond, to a height of 496 feet, while the ridge known as McKay's Hill, at the head of the lake, is scarcely under 500 feet. There is a narrow fringe of level land close to the margin of the lake, around which a good road has been constructed. The neat-looking cottages of the miners situated along the upper side of the road, with the manager's house and gardens, add much to the natural picturesqueness of the place.

For a full description of the mine and the various operations connected with its earlier development, a reference to your Report for 1867 will be found sufficient.

The country surrounding Tilt Cove is rugged and broken in outline, affording varied and often picturesque scenery. Long Pond, situated about half a mile west from the mine, together with its immediate surroundings, presents in the latter respect a most delightful picture. The hill ranges are for the most part bare of vegetation, while a scanty growth of timber is met with only in the ravines, forming the lower levels.

Wild Bight, a little over 2 miles west of Tilt Cove, is, as the name implies, merely an open bay, which facing eastward, and exposed to the full force of the Atlantic, affords no shelter to vessels or craft of any kind. At the extremity of the point of land extending eastward on the south side of the Bight, Round Harbour is situated, a small but very snug nook, having a narrow entrance to the oval-shaped basin inside, which renders it a secure resort for all ordinary sized coasting vessels.

Snook's Arm is the next indentation, extending inland from Round Harbour about 2½ miles in a north-westerly direction. It is one of the deepest inlets on the north shore of the bay, but owing to the straightness of its shore-line, does not offer a very safe retreat in bad weather. At its extreme head, close to the eastern side, shelter can be obtained under most circumstances, but the water is very deep close in shore, and there is little room for a vessel to swing. Vertical cliffs present themselves on either side of the arm, those on the western side being very abrupt, attaining at Snook's Head a height of nearly 600 feet. This conspicuous promontory, standing out from the general trend of the coast, is

distinctly visible from most parts of the bay. Snook's Arm and Red Cliff ponds, very picturesque sheets of water, are distant, the former about one, and the latter a little over 2 miles north-westerly from the head of the arm. The country in their vicinity partakes pretty much of the same character as that in the neighbourhood of Tilt Cove, being perhaps somewhat more wooded. Red Cliff Hills, whose bare rocky summits rise immediately north of the lake of the same name, form the central ridge and watershed of this part of the peninsula.

Between Snook's Head and Betts Cove, a distance of 4½ miles in a direct line, no place of any importance occurs; the coast is very rugged and precipitous. Wild Bight, the second of the name, another exposed bay, lies on the western side of Snook's Head. Indian Burying Ground, having a settlement consisting of three or four families, is situated about midway between Snook's Head and Betts Cove. Bobies Cove and Buttonhole Cove are merely insignificant creeks.

Betts Cove, the celebrated locality of the Betts Cove mine, demands special notice. The cove itself is about 30 chains wide at its entrance, but narrows quickly towards its extreme head, which only attains a breadth of 3 chains. It is about three-quarters of a mile in length, and has a slight curve towards the west. Perpendicular, sometimes overhanging, cliffs rise from the water's edge on either side; those on the eastern side being particularly grand and imposing. The débris derived from the disintegration of their summits frequently forms a sloping talus towards their base, hiding the lower portions from view. This is constantly being added to by fresh material falling from above, which renders them dangerous to approach. A few chains back from the head of the cove, another towering mass of rock stretches obliquely across, and trending westward, leaves a narrow ravine in which the busy little town is situated. A small stream rising from some ponds in the rear meanders through this ravine, which supplies the town with fresh water. Another little brook, or rather torrent, pours down a ravine on the eastern side of the cove, which, being provided with a wooden shute, affords great facilities to the shipping collected here during the summer for obtaining an abundance of pure, wholesome fresh water.

Two substantial wharves are ranged along either side of the

cove where several large vessels can lie at a time, ample means for securely mooring them being provided, such as piers, chains, and stout iron ringbolts fastened into the solid rock. These and other necessary appliances render the naturally exposed and otherwise poor harbour quite secure in all ordinary weather. A large iron buoy, anchored in the centre, adds greatly to the facilities for securing and warping in the shipping. The principal buildings, including a large shop and store, in which is the business and post-office, the neat cottage of the manager, and a number of other houses and stores, constitute the first row around the head of the cove. Immediately behind these are situated the barracks, the residence of the unmarried officials, a long low building, in which are also located the surgery and dispensary. Various other buildings, including miners' houses, boarding-houses, and a number of outhouses, occupy the background. The large new smelting works, with its six cupell blast furnaces, was erected last year close to the water's edge on the western side, at the outer extremity of the principal wharf. On the same side, higher up on the hill, and enclosed in large wooden buildings, are the two old reverberatory smelting works. Attached to one of these is a laboratory, fitted up for the assaying of all ordinary minerals. The tramway leading from the mine passes close by these latter buildings, where for the last 300 yards it is inclined at an angle of 20 degrees.

There is also a hoisting apparatus here attached to the smelting works, consisting of a stout iron wire rope, securely fastened to a bolt in the wharf and again at the top of the cliff. A large iron-bound oak tub is made to travel along this wire rope, by means of a pulley or sheeve, being hoisted from above by a small steam engine. Coal, brick, and other materials for the use of the furnaces are thus easily and rapidly conveyed from the wharf below.

The mine is situated just three-quarters of a mile west from the cove in a direct line. There is a good road leading to it, which, after winding up the ravine for a quarter of a mile, is turned suddenly back at a very sharp angle by a projecting spur from the hills, and after various bends and curves reaches the works in a distance of some 86 chains. A handsome wooden church and commodious hospital stand close to the roadside near

the first turn. Other buildings are met with farther along, and on approaching the mine itself there is quite a large collection. Lofty peaks rise above the general level on the north side of the road, and the whole surrounding country is bare of vegetation, and rugged in the extreme; but in the immediate neighbourhood of the mine the hills are less elevated and more rounded in outline, the average height above high-water mark being between 400 and 500 feet. The main shaft, over which an engine-house is erected, with powerful machinery for hoisting the ore, is sunk at the base of an escarpment known locally as Betts Head. Close to the mouth of the shaft there is a large copper floor, roofed over, upon which the ore received from the mine is spread out and sorted, the larger masses being broken up to a convenient size for handling, and freed to a great extent from useless rock and mundic (iron pyrites). These latter, together with all the loose débris, are carried out to an artificial island in a little pond close by, where they are well washed by hose and again carefully picked over. The better quality, under the name of fines, is afterwards shipped with the ordinary ore while the poorer material finds its way to the smelting works to be converted into regulus. A second large steam engine, erected during my visit in 1877, was employed at that time in driving two powerful steam drills, which were used in sinking a shaft on the eastern side of Betts Head Bluff. It was intended, after sinking some 400 feet, to excavate a tunnel from the underground workings to the loading wharf at the cove, through which a tramway having an easy down grade was to convey the ore; but I believe this undertaking has since been abandoned. At present the entire produce of the mine finds its way to the waterside by the tramway over the surface, being conveyed in strongly constructed wooden cars, furnished with four cast-iron wheels, and capable of containing two tons each. This tramway, which leads directly from the copper floor, consists of two stout iron rails laid along on wooden sleepers, either resting upon the ground or raised on piles according to the character of the surface. For the first 600 or 700 yards there is a slight upward grade, and horses are required to draw the cars along; then follows an incline of about 150 yards; another quarter of a mile of level, and finally the last incline of some 330 yards to the wharf. At each of these inclines there is a double track of four rails, over which two cars

ply at a time, one up and one down. A building called a break-house is erected at the top, which has a large wooden drum inside, whose motion is regulated by certain cranks and levers. A strong iron wire rope wound around this drum has either end attached to the cars, and is eased and guided along the centre of each track by wooden rollers, over which it glides smoothly while the cars are in motion. The impetus derived by the angle of inclination, and the weight of the full car descending, is sufficient to draw up the other even when half loaded. The cars themselves are of a peculiar construction, being somewhat longer than their breadth, wide at top and tapering downwards. The lower part is quite narrow, while the bottom, which is hinged on one side and bolted on the other, admits of being let down at pleasure, so that the contents can be readily emptied with ease and dispatch.

Having no official authority to demand access to the books or to the register of underground operations, I am unable to give details either as regards the expenses and profits of the mine, or the manner and amount of excavation performed, which would no doubt be of much general interest; and I beg to suggest, for the sake of such information being disseminated, that printed forms, such as are used by the Geological Survey of Canada, should be sent periodically to each mining locality, to be filled up by the respective proprietors or agents.

The annual yield of ore to the end of last year has been stated as follows:—

			Tons.
In 1874–5, when shipping commenced			8,000
In 1876	"	"	18,000
In 1877	"	"	44,000
In 1878	"	"	25,000
Making a grand total of			95,000

Proceeding still westward from Betts Cove, the coast-line maintains its rugged and precipitous character throughout its whole extent. About a mile from the cove rises Betts Head proper, that overlooking the mine being but the western extremity of the ridge, extending inland from the coast. A straight strip of shore immediately west of Betts Head is known as the lowlands—not that it is in reality very low, except as compared with the

country on either side. Burton's Pond, where the property of the Notre Dame Mining Company is located, adjoining that of the Betts Cove Company, lies just 2 miles west of Betts Head. The pond is a long, narrow, fresh-water lake hemmed in by lofty hills, and presenting rather a pretty scene. Its outlet is scarcely 100 yards from the salt water, and its surface level about 3 feet above high-water mark. There is no harbour here, but if the mine at any time prove sufficiently remunerative, I am of opinion that it would be quite feasible to make one of the pond, by means of a good wide canal cut through the narrow intervening strip of land at its outlet.

A considerable amount of work in the way of excavation has been done upon this location from time to time, but in such a desultory manner as hardly to entitle it to be regarded as mining. A large store and a few dwelling-houses stand on the bank near the foot of the lake, and some 50 or 60 tons of copper ore are piled near the entrance to the principal drift, just above high-water mark. The work here has, however, been suspended for some years past, and I believe the property is now held under lease by the Betts Cove Company.

Nipper's Harbour, well known by the little group of islands lying in front, and also as being the first naturally secure harbour inside Cape St. John, lies just a mile in a direct line west of Burton's Pond. There is an open cove between the two called Pitman's Bight, which is, however, a place of no consequence. Nipper's Harbour is not commodious, but there is a second or inner harbour entered by a narrow channel, perfectly land-locked, and much resorted to by small craft. There is a large but straggling settlement at Nipper's Harbour, comprising, besides various dwelling-houses, some large stores and the mercantile establishment of Messrs. Hodge and Co., a branch of the firm at Twillingate. Besides being the terminus of the northern mail steamers' route, the harbour is much resorted to by the large copper vessels while waiting their turn to load at the mines of Betts and Tilt Cove. I have seen as many as six such moored here at a time.

There are two or three wild uninhabited coves between Nipper's Harbour and Rogue's Harbour, the latter being situated 2½ miles farther west. Rogue's Harbour (properly Rouge Harbour) consists

of two arms, one of which, the western, is long and narrow. Small craft only can make use of this, but the North-west Arm is well adapted for large vessels. There is a shallow reef nearly in the centre of the entrance to this harbour, which has, however, plenty of water on either side of it. A remarkable cone rises on the point of land separating the two arms to a height of 539 feet, called Hammer Head, from the peculiar shape of its summit. Three or four families reside in the Western Arm, who appear in rather poor circumstances, having no land worth speaking of to cultivate, and therefore being entirely dependent upon the precarious shore fishery.

The eastern boundary line of the Rogue's Harbour mining grant cuts across this arm, including about 15 chains of its western end. Two shafts have been sunk in the low ground near the head of the arm, from which several tons of fine yellow sulphide of copper were raised; while about a quarter of a mile back a drift has been made in the hillside, towards the south-west, bounding the narrow depression extending westward from the arm on its south side; but at present the work is suspended.

The outer shore line for over 2 miles farther to the entrance to Stocking Harbour is pretty straight and regular, with low cliffs facing the sea. Stocking Harbour has a wide open entrance, with three or four small islands stretching across. The safest anchorage is in a cove on the eastern side. There is a long narrow inlet on the western side of the harbour, with a salt-water lagoon extending half a mile or more still farther inland; but this arm is almost completely barred off by sunken rocks lying in the centre of the narrow entrance. There are a few inhabitants residing here, but the place has a very uninviting appearance.

This harbour is fairly within Green Bay proper, the extreme eastern point of which, on the south side, bears from the entrance to Stocking Harbour S. 48° E., true; distant 2½ miles. From this latter point, Green Bay, which includes three large arms, viz. North-west Arm, Middle Arm, and South-west Arm, stretches first westerly nearly 7 miles, then south-westerly 11 miles to its extreme head. The two first-named arms are situated on the north side of the bay, about 2 miles apart, North-west Arm being about an equal distance to the west of Stocking Harbour. It has a comparatively narrow entrance, but expanding

inside into a wide picturesque basin forms an excellent harbour in all weathers. The soil being pretty good in some parts of the arm, and an abundance of timber in the neighbourhood, a number of persons have been attracted hither, most of whom have nice clearings and appear to be comfortably settled. Nicky's Nose, a remarkable headland, is situated on the south side, nearly opposite to the entrance of this arm.

Middle Arm, facing exactly eastward, is a very straight indentation, tapering gradually towards its head, from whence a narrow gut leads into a wide shallow lagoon, which is again separated from a fresh-water pond inside by a very small space. The arm is much exposed, affords but little shelter, and is rendered bleak and uninviting in appearance by the bare-topped and rugged outline of the hills, which rise to considerable elevations, and the abruptness of the shores on either side of it.

Jackson's Cove, the only harbour on the south side of the bay, is nearly opposite Middle Arm. The land around the cove is low, and the soil of good quality. There are several settlers, who live principally by the produce of their small farms, and appear to succeed, and to be in comfortable circumstances. Jackson's Cove is probably destined to become a thriving place, from its proximity to the new mines recently opened up in South-west Arm. Between Jackson's Cove and the eastern point of Green Bay there are five other exposed coves, three of which are inhabited, viz. Taylor's Cove, Jerry's Cove, and King's Cove. There is excellent soil in each of these, but they afford no shelter as harbours.

South-west Arm, the most important and extensive of the three arms of Green Bay, is simply the prolongation of that bay after it begins to contract in width. Middle Arm Point, on the north side, and Birchy Head on the south, may be said to form the entrance to this arm. Starting from a point midway between these, the following courses and distances would lead up the centre of the arm:—S. 47° W., true, 7 miles 20 chains to Mansfield Point; thence S. 10° W., true, 2 miles 30 chains; thence S. 55° W., true, 1 mile to the head of the arm. It averages only 60 chains in width between Birchy Head and Mansfield Point, but widens out beyond to about a mile and a half, contracting again towards the extreme head. The shores of the arm to Mansfield Point are tolerably straight, and no indentations of any importance

occur on either side, those on the north being for the most part precipitous, and rising into bare-topped bleak hills of considerable elevation. On the south side, on the contrary, they are low and densely wooded, except at Naked Man, situated nearly midway between Birchy Head and Mansfield Point, where they rise pretty steeply to heights of 300 and 400 feet, but are still wooded to their summits. Naked Man is a solitary outlying pillar of rock, standing upright at a distance of several yards from the cliff, and so situated at the northern bend of the shore as to render it a conspicuous object, visible for long distances up and down the arm. This has lately become a place of note, from the fact that two very promising mining locations, both being actively worked at present, are situated on either side of a line running south magnetic from the Naked Man Rock. Operations were commenced on both during the past summer, and so far with apparent success. A new English company have taken up the easternmost location, and were engaged during our visit in driving a tunnel into the hillside from near the water's edge, so as to tap the mineral-bearing band, which strikes down a ravine running obliquely to the trend of the shore. The object of this tunnel was twofold; first, to prove the band at a low level, and secondly, to save tramming over the steep and uneven surface. Three shafts had been previously sunk on the band from above by the owners of the property, Messrs. White and Browning, from which much good ore was extracted.

The western location is now in the hands of the Betts Cove Company, and the work is being rapidly pushed forward. Already several houses and stores have been erected, and a tramway having a very steep grade was in course of construction during my last visit in October 1878.

Much of the ore found here is of a superior quality to that usually met with in other parts of the bay, yielding, as I was informed, 26 per cent. of pure copper. Recent accounts from this quarter, which may be relied upon, are of a most favourable character.

There are three other mining grants on the south side of the bay,—one at Nickey's Nose Head, one between Birchy Head and Naked Man, and the third between Naked Man and Mansfield Point. On only one of these, that between Birchy Head and Naked Man, has any attempt at mining been made. A large

store, several houses, &c., have been erected on this property, and a good road constructed from the waterside to the mine, about a quarter of a mile in length. Two or more shafts have been sunk in a vertical stratum of chloritic slate to depths of 30 or 40 fathoms, from which several tons of ore were extracted; but the work has been suspended since the spring of 1877.

At the extreme head of South-west Arm there is an excellent harbour, formed by a low projecting point on the north side, known as King's Point, where the water is deep close to the beach, which is admirably situated for the construction of wharves and piers. The soil on this point is of excellent quality, and the same character applies to that of the country surrounding the head of the arm, and for several miles westward. A few settlers have recently established themselves at King's Point who are commencing small clearings.

There can be little doubt that the mineral developments, abundant timber, and good agricultural lands of Green Bay, and more particularly those of the South-west Arm, are destined to create it an important locality at no remote period.

A narrow and shallow strait separates Green Bay Island from the eastern point of the bay. This island has an area of about 1000 square chains, but being for the most part barren and exposed, is not inhabited.

The Three Arms, properly so called,* viz. Western Arm, Middle Arm, and Southern Arm, are three long inlets, situated between Green Bay Point and Little Bay Head. Western Arm is 7 miles long, but very irregular in breadth, varying from 20 to 60 chains. Harry's Harbour, on the north side, is the only inhabited place in the arm, and is separated by a very narrow neck of land from Jerry's Cove in Green Bay. Bear Cove, near the head of the arm, is a very picturesque place, and the soil around its shores is of good quality. A road leads hence across to Jackson's Cove, three-quarters of a mile distant, along which route the land is low, and covered for the most part with excellent soil.

From the bottom of Walsh's Cove, on the south side of the arm, a path a quarter of a mile in length crosses to the head of

* Much confusion frequently arises by confounding these with the Three Arms of Green Bay, just described. Properly speaking, they are the Three Arms of Notre Dame Bay, or simply the "Three Arms."

Middle Arm. This arm is only about 2½ miles deep, and quite narrow. A large island lies partly in the entrance, having a navigable channel on either side, with a safe and commodious harbour at the upper part of the arm above it. There are several inhabitants in this arm, who chiefly reside upon the island, and appear in good circumstances. Another large island, Innis Island, and some smaller ones, lie just in front, which help very materially to break the force of the sea as it heaves in from the open bay outside. The mining grant owned by Mr. James Norris of this place, occupies nearly the whole of the little peninsula on the north side of Middle Arm. A Mr. Brown, of Nova Scotia, having leased the property, was employed while we were there in sinking a shaft just above high-water mark, with the intention of drifting under water, after reaching a depth of about 45 fathoms, to intercept a band containing copper which was observed at low tide; but I understand the place has since been abandoned.

The Southern Arm, which is pretty straight and narrow, and about 6 miles in length, is separated from Middle Arm by a long, tapering, spear-shaped point of land. It has for its southern boundary the north shore of the Little Bay Head peninsula, which is for the greater part extremely precipitous. There is an island in the centre of the arm, and immediately opposite on the south side is the narrow entrance to Shoal Arm, a round lake-like basin, but owing to its shallow entrance not available as a harbour, except for craft of very small draught. Southern Arm is destitute of inhabitants; the barrenness of its soil not offering any inducement to settlers, while it has too long an indraft for the purposes of fishing establishments. Two good-sized brooks flow in at its extreme head, between which at about a mile and a half inland, a very conspicuous mountain, known as the Blow-me-down, raises its bare-peaked summit high above the surrounding country. There is a good deal of fair timber covering the surface of the country in and about these arms, and westward towards the south-west arm of Green Bay.

The most conspicuous feature in all the upper part of the bay is Little Bay Head, the eastern extremity of the peninsula above named. Its beetling cliffs, whose jagged ledges form a nestling place for the cormorant and various other sea-birds, rising vertically from the water's edge, are crowned on their summits by

several elevated ridges, of which Hare Hill is the most prominent. The latter is visible for long distances, and was of essential service as an object for the triangulation from all the points on the north shore of the bay.

Little Bay is a deep inlet, situated between Little Bay and Hall's Bay Heads. It has a wide open mouth measuring over 4 miles across, but about half-way up the bay it suddenly contracts to less than half a mile. Otter Island, nearly a mile and a half long, by half a mile wide, lies just in front of the narrows; its tapering wedge-like western end projecting so far inwards as to leave but a narrow space on either side between the island and the main. These are known as the Northern and Southern Otter Tickles. Inside the island the bay continues very contracted but irregular in width. Shell Bird and Woody Islands occupy respectively large portions of two of the more expansive parts of the arm, which again at its extreme head expands slightly; the total length of the bay being nearly 9 miles.

Four miles inside of Little Bay Head, on the north side of the bay, is the first indentation, called Wild Bight. It is merely an open cove facing the east, with a long projecting point on the south side, off which lie a couple of rocky islands. The inner part of the cove, owing to its long indraft, affords some shelter to small craft, and is a fairly good harbour in summer time. There is some nice land, and the half-dozen families residing in the cove appear pretty well to do. Four miles farther, on the same side of the bay, is another open cove called Indian Bight, which has recently become known as the locality of the "Little Bay mine." The mine is situated on the point of land between the Bight and the Northern Otter Island Tickle. The extraordinary development displayed at this place in a short time is worthy of more than a passing notice. On the 27th day of July last I arrived at Indian Bight while prosecuting my survey of Little Bay, and camped on the unoccupied beach. The place had never been inhabited, and presented at the time as wild and forlorn an appearance as any in the Bay of Notre Dame. The mine had just been discovered, and I had the pleasure of accompanying the first exploring party who visited it. A tramp of a quarter of a mile through the woods and marshes brought us to a depression, in which a low swampy morass and a string of small tarns occupied the lower ground,

with a bare ridge of rock on either side. Close by one of these tarns, on the south side of the depression, an exceedingly ferruginous mass of chloritic slate rock, frequently stained with the green carbonate of copper, was seen to butt up against the rock wall. An inspection of the place soon proved that the copper stains were indicative of something more than the mere presence of the ore, especially when several pieces of slate, well charged with bright yellow copper sulphide, were quarried out. The character of the ore-bearing stratum, and the manner in which the ore was distributed, together with its position in the formation, gave fair promise of its becoming eventually a valuable mineral property. Shortly after leaving, to proceed southward, a few miners arrived, and immediately commenced operations on the mineral band. My next visit to the same place was on the 6th of October, after terminating the survey for the season, and I was not a little astonished to observe the changes that had taken place during the short interval between these visits. The level space in rear of my former camping ground was now occupied by a pretty little town, which already boasted three regularly laid out streets, cut through the woods parallel with the shore, along each of which a range of comfortable houses were rapidly being constructed for the accommodation of the miners, now numbering over 500 individuals. At the waterside stood a large well-built store with a fine wharf in front, close by which was the shop and office; and in rear of these again the manager's and officials' temporary residence. A fine new house, prettily situated amongst the trees on the north side of the cove, and destined for the permanent residence of the manager, was in course of construction; besides two others for the principal officials. A wide track cut through the woods leads to the mine, from whence a well-constructed tramway, three-quarters of a mile in length, conveyed the ore to the shipping wharf on the opposite side of the peninsula in Otter Tickle. Here a large iron steamer was rapidly loading, this being the second cargo shipped up to date. Near the wharf stood one or two more buildings, and the foundation of a large new smelting establishment was already laid.

The mine itself partook more of the character of an open quarry than otherwise. So far, all the ore had been taken out from near the surface, by blasting and quarrying down the sides

of the bluff in huge masses; long drills, making holes of 8 and 10 feet, being used for the purpose. The greater part of the ferruginous cliffs had disappeared, and a wide level space now occupied the place where it stood. The morass and one of the small tarns had been drained and partly filled up with the refuse material from the mine, which was fast converting them into dry land. Into the vertical wall, which now formed the southern boundary of the depression, some half-a-dozen drifts had just been commenced; while in front, along the strike of the mineral band, and again on the top of the ridge, men were busily engaged sinking shafts; these being the preliminary operations for obtaining sufficient space underground previous to the setting in of winter.

Some 3000 tons of ore had been produced from the mine up to this time, and since my return home I have learnt that the total amount shipped up to the end of the year reached no less than 10,000 tons; or an average of 2000 tons per month, since the inception of the mine, just five months previously.

Such extraordinary activity on the part of the Betts Cove Company, who have leased the property, is mainly due to the skill and energy displayed by their indefatigable manager, Mr. Francis Ellershausen, whose dashing enterprise and admirable administration has given the mining interests of Newfoundland an impetus which may produce results rivalling any known in the greatest mining regions of the globe.

Operations were also commenced during the year upon another mining location, at a place called Shoal Arm in the inner part of Little Bay, by Captain Brown, of Nova Scotia; but as the place did not prove very promising, it was abandoned before I left the bay.

Directly opposite Otter Island, on the south side of Little Bay, a deep bight, wide and open at first, but gradually contracting, and finally turning sharply to the westward, affords a safe retreat for small vessels, and is known as Little Ward's Harbour. It is uninhabited at present, but upon a former visit in 1871 there were then two resident families. A narrow isthmus, less than a quarter of a mile in width, separates this place from a long shallow and irregular salt-water lagoon, which has its entrance on the north side of Hall's Bay. From this isthmus the land widens

out eastward, forming the peninsula of which Hall's Bay Head proper is the elevated north-eastern extremity. Immediately in front of the open mouth of Little Bay, and scarcely a mile and a half distant from Hall's Bay Head, lies Little Bay Island, which in point of business, number of inhabitants, &c., has the largest settlement in this portion of Notre Dame Bay, and is well known as a port of call for the mail steamer. The island is very rugged, but possesses an excellent land-locked harbour. It was not surveyed this season, but several points were fixed on the triangulation.

The fine inlet of Hall's Bay, over 19 miles in length, and with an average width of fully a mile and a half, is nearly equal to Green Bay in size and importance. It is so straight that a course of S. 55° W., from the true meridian, may be steered up its centre, from a point 6 miles outside, which would clear all obstructions till it strikes Dock Point, within $2\frac{1}{2}$ miles of the extreme head. The shore on the north side is at first bold and precipitous, rising at Indian Head, the first headland inside Hall's Bay, to a height of 455 feet; but beyond, westward, the lofty precipices give place to low cliffs, with occasional intervening gravel beaches. Three miles west of Indian Head is the entrance to Salt-water Pond, already mentioned, the outer part of which being wide and deep, and containing several small islands, offers abundance of room and good shelter, being in fact the only safe harbour in Hall's Bay. The shore, hence to the mouth of Indian Brook, a distance of nearly 9 miles, presents an almost unbroken front. Bob's Head is a bluff on the coast about 2 miles west of Salt-water Pond, opposite which, on the south side, is a place called Boot Harbour, where a man named Thistle has recently established a shingle mill, and is doing a thriving trade. Mansfield Head, a very prominent point on the south side of the bay, lies $2\frac{3}{4}$ miles west of Boot Harbour. The shores for some distance on either side of Mansfield Head are very bold and jagged, but, like those of the north side, they tone down to low sloping banks towards the head of the bay. At the mouth of Indian Brook, which is wide and shallow, fairly secure harbours are obtainable inside the western ends of two small islands lying across the open entrance. On the easternmost of these islands a large steam saw-mill, the property of Mr. Udell, of Harbour Grace, is erected; but was not in operation during the summer.

The beautiful stream of Indian Brook, taking its rise some 40 miles in the interior, and flowing through a narrow fertile valley, is the largest river in this section of Notre Dame Bay, and has long since attracted attention. In your Report of 1866 a description of the valley will be found, and particulars related regarding its capabilities as a lumbering and agricultural district. Two other considerable streams flow in near the head of the bay; West Brook at the extreme western end, and South Brook about 2 miles from the head on the south side. Between these two streams a bold projecting point of land, called Wolf Head, divides the upper part of the bay into two open coves. Several very fine tracts of land occur along the shores of this portion of Hall's Bay, but especially at the mouths of the three above-named rivers, that of West Brook in particular, where for several miles back it is quite level, and the soil of excellent quality. Not long since the whole country on either side, and for many miles into the interior, was covered with a dense growth of the usual forest-trees down to the water's edge; but recent fires have swept over and destroyed a very great portion of this valuable timber, ruining, moreover, in no small degree, the picturesque effect an evergreen forest usually presents.

Only some half-dozen families at present reside in Hall's Bay, most of whom are Micmac Indians, who live chiefly by hunting and furring in the interior.

The Hall's Bay mining location, the only one on which any attempt at mining has been made, is situated on the north side, about 2 miles below Indian Brook. It commences at a little cove called Island Rock Cove, but the mine itself is nearly a mile back from the shore. Several shafts have been sunk upon the ore-bearing rock by the Betts Cove Company; but the result, so far, though giving fair promise, has not hitherto proved altogether satisfactory.

Sunday Cove Island is situated in the entrance or mouth of Hall's Bay. Its form is long and wedge-shaped, bearing somewhat of a rude resemblance to a human leg and foot. Its greatest length is 6½ miles, lying east and west, true; and the widest part across, which is on the eastern coast, lies north and south 4 miles 50 chains. The main entrance to Hall's Bay, usually called the Ship's Run, is on the northern side of Sunday Cove Island, while

a smaller but very picturesque channel, called Sunday Cove Tickle, is accessible for boats and small craft, where there is perfect shelter at all times, although it is unfortunately too shallow at its narrowest part to permit the passage of vessels drawing over 5 feet of water. The island shore of the Tickle is tolerably regular and merely indented with a few small coves, but on the opposite or mainland side two large arms, viz. Shoal Arm and Woodford's Arm occur, besides Nipper's and Stag Coves, all of which are good harbours.

Sunday Cove Island is for the most part rugged but densely wooded. Chaney or Chinese Head, on the north side of the island, is a very prominent headland, its lofty, vertical or overhanging cliffs displaying to an unusual extent the remarkable concretionary or semi-columnar aspect so often met with in the cliffs throughout the region. There are some nice patches of land on the island, and two considerable settlements are situated, one on either side of the northern projecting point, which are connected by a fair road across the island three-quarters of a mile long.

Many indications of copper have been met with in the numerous bands of chloritic slate which occur on the island. The whole island is at present held under lease by Captain Cleary, of St. John's, who has been diligently engaged in mining adventure for some years on the locality; but though many promising ore-bearing bands were discovered, no well-defined deposit has as yet rewarded his persevering efforts.

An archipelago, or great group of islands, lies in front of Hall's Bay, comprising, besides the numerous smaller isles and islets, three large islands, viz. Pilley's, Long (sometimes called Ward's Harbour Island), and Great Triton Islands; while the smaller group, called the Stag Islands, lies well out in the bay to the north-east of Long Island. The positions of many points within the group have been fixed on the triangulation, and portions of Pilley's and Great Triton Islands were surveyed, but the details are still incomplete, as my time was fully occupied in minutely surveying the mainland.

Long Island Tickle or Reach is that fine navigable passage lying between Long Island, Pilley's, and Great Triton Islands. It is usually adopted by the northern mail boat coming up and

going down the bay, between Exploits and Little Bay Islands. Pilley's Tickle, which separates Pilley's and Great Triton Islands, is a narrow, tortuous channel, and only navigable with difficulty towards the southern end, owing to a number of shoals and rocks.

South from Hall's Bay, or rather Sunday Cove Tickle, the shore of the mainland is much indented by small coves and creeks. Hayward's Head, a bluff round-topped jutting point, connected by a narrow isthmus, lies on the south side of the entrance to the Tickle, and has Hayward's Bight, a wild exposed cove, on its western side, and Devil's Cove on the eastern. South of the latter two other small coves occur, Hayward's Cove and Bear Cove. Opposite the point which separates these two coves, and about midway between it and the western shore of Pilley's Island, there is a large island called Hayward's Gull Island.

The beautiful inlet of Rabbit's Arm, which is the most important in this neighbourhood, lies just south of Bear Cove. It is entered by a narrow channel, in the centre of which stands a small island; but the arm expands within, producing a wide and picturesque basin, with a great diversity of shore line, presenting alternate steep rocky cliffs and bluff points with low flats of good land, especially on the southern and western sides. Three or four families occupy these intervals, and have commenced clearing the ground, the soil being apparently of excellent quality. Within three-quarters of a mile of the head of the arm, and connected by a path cut through the woods, there is a charming sheet of fresh water, locally known as Rabbit's Arm Pond, but which I have renamed Crescent Lake, from its crescent-like form. I took occasion, while at Rabbit's Arm, to survey this lake, as it probably may shortly become a place of importance, owing to the recent discovery of copper near its north shore. The property is held by Captain Cleary, who, at the time of my visit, was engaged costeening the surface, which is covered not only with dense forest, but also with a considerable deposit of drift soil. Although the general character of the rocks in the vicinity, as well as that of the ore itself, differed materially from other deposits in the bay, the indications were nevertheless so promising that I felt quite warranted in expressing a favourable opinion of the prospects of the place, and am happy to learn that recent accounts fully justify that opinion. Mr. Ellershausen, who has leased the property, has now between

thirty and forty men employed sinking trial shafts, and otherwise preparing for more extended operations in the spring. A telegram from him, a few days since, addressed to Captain Cleary, to whom I am indebted for its publicity, is to the following effect:—

"Rabbit's Arm turning out well, No. 1 ore yields 27·7, expect to have 500 tons out by the spring."

The north shore of Crescent Lake is for the most part low, sloping gently upwards from the water's edge into a hilly background, while the southern shore, on the contrary, presents a bold mural front for the greater part of its extent. A large stream enters the lake on the south side, about a mile and three-quarters from its western end, which is navigable for canoes for a distance of 10 or 12 miles. Another smaller stream also flows in at the western end, while the lake discharges itself in a fine river only some three-quarters of a mile long at its extreme south-eastern angle. This river, which might easily be made available for lumbering purposes, with very little expense, and can be navigated at any time by canoes or flat-bottomed boats, does not, as might be inferred, debouch into Rabbit's Arm, but into Sop's Arm, farther south.

The entire country for many miles back is densely wooded; pine, spruce, fir, birch, and aspen being abundant, and frequently of excellent quality. The character of the country, in several places along the shores of the lake, together with that of the indigenous produce of the forests, give promise of a soil of good quality. Altogether the place is most favourable in every respect for the successful development of mining, lumbering, agricultural, and kindred enterprises.

A long, jagged peninsula extends eastward from Rabbit's Arm about 3 miles, which, passing south of Pilley's Island, leaves a channel averaging about a quarter of a mile in width. Three small coves, known as Hammer Cove, Measles Cove, and Tilley's Cove, occur on the north side of this peninsula before reaching Pilley's Island. The narrowest part of the channel, between Pilley's Island and the mainland, which has a low rocky islet in its centre, is called Flap Rock Tickle; while at the eastern extremity of the peninsula another wider channel, leading out into Sop's Arm, occurs, known as Raft Tickle. This latter is bounded on its eastern side by a high wooded island named Pretty Island,

which also gives its name to the narrow strait that separates it from the south-west end of Great Triton Island. The space enclosed within these tickles, and between these great islands and the main, is studded with several small islands and islets, while rocks and shoals are also of frequent occurrence; there is nevertheless a navigable channel through which those acquainted with the intricacies of the locality are in the habit of passing with their boats and schooners. I have ascertained by sounding that it is quite feasible for, and might be availed of at times, our coastal steamers, especially in the spring, when the outer part of the bay is liable to be jammed with ice, cutting off, or at all events rendering hazardous, all approach to the ports of call within.

When entering from the open Bay of Notre Dame outside, the southern shore of Great Triton Island may be kept close aboard, and followed at a distance of 200 or 300 yards. This side of the island is very straight, trending about west by north magnetic, and is for the most part bold, being free from outlying rocks and shoals. On approaching the western end of the island, Pretty Tickle is brought open, bearing north-west by north; when the following table of courses and sailing directions, if strictly adhered to, would bring a vessel through in safety:—

SAILING DIRECTIONS.

No.	Course.	Distance.	Remarks.
		mls. chs.	
1	N.W. by N.	0 46	Steer carefully through the centre of Pretty Tickle, directly for a low island rock which seems to bar it across inside, till within a distance of about 150 yards of the rock, or till the extreme western end of Great Triton Island is brought well open.
2	N.W. by W. ¼ W.	0 20	A very narrow passage is now perceived between the island rock and the north side of Pretty Island. By keeping the bold shore of the latter close aboard, and steering very carefully, or in the case of a steamer going at dead slow speed, this most intricate and shallow part of the whole route (having but 5 fathoms at half tide)* may be easily cleared.
3	W.N.W. ¼ W.	0 68	Once past this difficulty, Fox Island, now open to the westward, can be run for without hesitation. Nearing Fox Island, the course should be shaped so as to pass a little to the south of it, or between it and another small island close by. There is no danger here, the narrowest part of the channel having 10 fathoms of water.

* On no account should any attempt to pass the rock on the north side be made.

SAILING DIRECTIONS—*continued.*

No.	Course.	Distance. mls. chs.	Remarks.
4	N.W. ¾ N.	0 71	When the western end of Fox Island is brought fairly open amidships, and Flat Rock Tickle clearly exposed to view, a straight course must then be steered directly for the most southerly point of Pilley's Island, which will just clear the northern end of the Flap Rock at about 60 yards distant.*
5	N.W. by W. ¾ W.	0 30	Once Flap Rock is passed, off which there are 10 fathoms of water, the course must be quickly altered, and the vessel's head hauled off to the westward so as to clear the point of Pilley's Island, which being passed, no further danger need be apprehended from rocks or other obstructions. A wide, open waterway now leads around the south-west end of Pilley's Island, and when its western side is brought well open, and the wide passage between it and Hayward's Gull Island fully exposed, the vessel is headed to the north.
6	N.N.E. ¾ E.	3 20	This course passes Hayward's Gull Island to the east, giving it a good berth, and leads on towards Sunday Cove Island. It will also clear a dangerous rock lying off the most westerly point of Pilley's Island.

If it should be preferable, as it most probably would be, to take the Raft Tickle instead of Pretty Tickle when approaching from outside, and thus avoid the narrow and shallow passage referred to in No. 2 course, it would be only necessary to pass south of Pretty Island until the wide channel of Raft Tickle is brought open at its western end. Then Fox Island and the smaller islands near it (see map) are seen distinctly ahead through the open Tickle. By steering for the centre of this smaller island, bearing north by east magnetic, a clear passage will be found till the island is close aboard, which may then be passed on either side in perfect safety; and the course, No. 4, from Fox Island, resumed as before.

The bearings given in the above courses are all magnetic, the average variation of the needle here being about 32° west. But I would not recommend trusting entirely to the compass, as it could hardly be depended upon to act sufficiently quickly in the short turns. Close attention to the directions and landmarks given will be found to carry a vessel through, and no danger need ever be apprehended from the action of heavy seas.

* The southern side of Flap Rock must by all means be avoided.

The south shore of Pilley's Island, which bounds the northern side of Flap Rock Tickle, and extends eastward in line with Pretty Island, has two or three deep indentations. Of these Salt Pond is a remarkably picturesque place. It has a very narrow entrance, but expands within, opening out into a wide basin, from whence extend on all sides deep coves and intricate creeks; while a number of small islets, distributed about the inlet, lend a charming effect to the scene. The largest of these groups I have named Linfield's Islands, after a young man who built a schooner here last winter. An isthmus of a couple of hundred yards only in breadth separates Salt Pond from the head of Bumblebee Cove, a deep bight extending westward from Pilley's Tickle. A mining grant, owned by Mr. Goodfellow and others of St. John's, is situated on the north side of this latter bight; and there is a second grant held by the same parties in Pilley's Cove, near the north-east angle of the island, just at the entrance to Pilley's Tickle. No work has as yet been done on the former of these, but a trial drift into the face of a cliff, stained with green carbonate of copper, on the south side of Pilley's Cove in the latter, failed in striking a supposed lode or mineral-bearing band.

Sop's Arm, a deep and important indentation of the general shore line, lies immediately south of the tickles and islands above described. It may be said to commence at the western point of Badger Bay, from whence it extends south-westerly nearly 6 miles, and is divided at its upper end into three separate smaller arms, viz. Western Arm, Middle or Tommy's Arm, and Northern Arm. It is bounded on the northern side by Great Triton Island, Pretty Island, and the peninsula projecting eastward from Rabbit's Arm. Western Arm, the largest of the three minor arms, is separated by a long tapering point from Middle Arm. Its shores are tolerably straight on either side, for the most part bare and rocky, with little or no soil; and there is an island of nearly half a mile in length, almost in the centre. A nice stream flows into the western end, coming from a number of small ponds in the rear. Middle Arm is about the same length as Western Arm, but very much more contracted in width. The shores, especially on the southern side, are frequently abrupt and precipitous, vertical cliffs bounding the latter for a considerable distance, but give place to low sloping banks towards the head of the arm. In the middle

there is a long, low island, and some island rocks. This is the arm which, at its western end, receives the waters of the large river flowing from Crescent Lake. Northern Arm cuts into the land opposite the southern point of Middle Arm. It is about a mile long, has several small inlets near its entrance, and is only separated by a strip of land some 6 chains in width from Tilley's Cove on the north side of the peninsula. There are no inhabitants in any of these arms; the character of the soil, except in a few isolated spots, being very inferior, while extensive fires have swept over the country to the south and west, destroying the entire dense forest which at one time flourished.

Towards the eastern extremity of the land, on the south side of Sop's Arm, there is an indentation of nearly a mile in depth, forming a capital harbour, and known as Burton's Cove. The Sugarloaf, a remarkable cone-shaped island, is situated about half a mile to the eastward, opposite the entrance to this cove.

The Duck Islands are a large group lying close in shore abreast of the western point of Badger Bay. The largest of the group is a high, wooded island, nearly a mile long, and is only separated by a very narrow passage from the mainland of the point.

The mouth of Badger Bay, facing the north-east, measures 3¼ miles across from the northern end of the larger Duck Island, to the extreme eastern point of the bay. From the latter point the bay stretches away to the south-west a little over 9 miles, and is indented towards its head by three arms and several small coves. The western shore runs nearly straight for the first 3 miles, terminating in Julie's Harbour, a small but very safe little nook. A wild exposed cove, east of Julie's Harbour, forms the head of the Western Arm, which is separated by a long tapering point from Shoal Arm, being the fourth of the same name mentioned in this Report. Shoal Arm stretches south-westerly something over 3 miles, contracting about midway to a width of only 6 chains. Inside this narrow strait it expands again into a wide shallow lagoon, which is generally about half dry at low tide. Good shelter for small craft can, however, be obtained close by a little island just inside the Narrows. A nice stream flows in at the head of the arm, and there is a small extent of level land near its mouth where the soil is of fair quality. The southern shore, outside the Narrows, trends away eastward for a mile and a half, then sweeping

round to the southward, produces another open bight called Beaver Cove. Several small islands, and one large one named Gull Island, a mile and a half long, by three-quarters of a mile wide, are situated close by the shore off the most northerly bend between Shoal Arm and Beaver Cove. An extremely bold headland, three-quarters of a mile wide, forms the projection between Beaver Cove and Wild Bight, this being also the fourth of that name in the upper portion of the bay alone. Wild Bight is the deepest indentation, as well as the most expansive of the three arms, and is in reality the extreme head of Badger Bay. Its shore line is more or less abrupt, and the country in the vicinity partakes almost of a mountainous character. The entire eastern shore of the bay, which is very straight, presents a similarly abrupt and frequently precipitous outline. There is but one small break in the cliff, a mile and a half from the eastern point, called Locke's Harbour. Small schooners can ride here in safety during ordinary summer weather. Three good-sized brooks flow into the head of Wild Bight, of which Pinney's Brook, on the western side, is the largest. The brook on the eastern side of the bight tumbles over a high cliff, and produces a pretty cataract, which is split into three distinct channels by projecting points of rock.

There are no inhabitants in any part of Badger Bay. Its naturally rugged and uninviting appearance is rendered all the more desolate from the forest having been entirely demolished by fire. Although Great Triton Island, which stretches across Badger Bay, would appear, from its position, to afford shelter within, the breadth of the strait, which is over $2\frac{1}{2}$ miles, together with the wide and open entrance of the bay itself, reduce the apparent advantage to be derived to a minimum; hence the effects of north-east gales are severely felt, even at the extreme head of Wild Bight.

With Badger Bay the season's survey terminated. By reference to the map accompanying this Report, I apprehend that no difficulty will be experienced in following out the descriptions given. If I should appear to have been unnecessarily minute in this description, I beg to remind you that in a mineralised region such as this, the metalliferous ores may be discovered in many remote and hitherto unknown localities, raising them at once into places of importance. The merest islet or rock, the most wild and

uninhabited creek or cove, or the shores of the most lonely and unfrequented lake in the district, may contain their mineral deposits. As an example, I need only cite the case of the Little Bay Indian Bight mine. The name of this locality was unknown, except to some ten or twelve persons, previous to the discovery of the mine seven months ago, while at the present time it is nearly as well known and as celebrated as Betts Cove or Tilt Cove.

In conclusion, I beg to state that the work of the two last seasons, of which the foregoing is a description, has been plotted on a scale of 2½ miles to an inch, which was subsequently reduced to a scale of 1 mile to an inch, to correspond with the other manuscript maps of the Geological Survey.

I have the honour to be, Sir,

Your obedient servant,

JAMES P. HOWLEY.

To Alexander Murray, Esq., C.M.G., F.G.S.,
Director Geological Survey, St. John's.

CHAPTER XIX.

REPORT FOR 1879.—BORING OPERATIONS NEAR THE GRAND POND —SURVEY OF THE WEST BRANCH OF THE HUMBER RIVER, &c.

ST. JOHN'S, *December 26th*, 1879.

SIR,—The result of the experiment made during the late season in the central Carboniferous trough of the island, by boring for coal, has been reported to me by Mr. James C. Cooper, mineral borer and superintendent of the party thus engaged, which in substance is as stated below. Before entering upon the details of the work, however, it is essential that some account should be given of the inception, organisation, and equipment necessary for its fulfilment; as, in consequence of the novelty of such operations in this country, the difficulty of transporting heavy material, especially overland, and sundry defects which were ultimately discovered in the supply of the requisite machinery, the operation has been much more limited in extent and less satisfactory than it otherwise might have been.

Through the kindness of Mr. Pulteney, of Coultbridge Calder Iron Works, the Government were advised that the Messrs. P. and W. McClellan, of Glasgow and London, had engaged to supply the necessary machinery for coal boring complete; who engaged also to forward the apparatus to St. John's, Newfoundland, by the Allan steamer leaving Liverpool on the 13th of May. The Government were further advised that an experienced mineral borer, Mr. James C. Cooper, was to proceed thence by the same conveyance at the same time. The steamer *Hibernian* left Liverpool on the day specified, and arrived duly at St. John's on 21st of May, having Mr. Cooper on board as a passenger; but he brought no machinery, nor any part of the boring gear. The non-arrival of the latter was not only very disappointing, but occasioned the direct loss of a whole fortnight's time, which, in this precarious climate, is of itself an item of no small importance,

while the borer had no opportunity for ascertaining how the apparatus fitted, or of remedying any defects which might have been detected, before leaving St. John's. The machinery arrived at length on the 3rd of June, coming by the mail steamer which left Liverpool on the 27th of May, and no time was lost in getting it removed to the wharf of the local coasting steamer, thence to be conveyed to the Bay of Islands. During the short interval of time between the arrival of the Atlantic steamer and the departure of the *Curlew* on her coastal voyage, viz. about four whole working days, Mr. Cooper made a hurried examination of the various fittings, and perceiving certain deficiencies which had to be supplied, and sundry alterations which had to be made, he found it necessary to employ a working engineer of this place to put the machinery in something like workable order. On the 10th of June, Mr. Cooper, with the bulk of the machinery and a party of eleven men, inclusive of one to superintend the commissariat, sailed for the Bay of Islands; he being also accompanied by Mr. James P. Howley, an assistant, and four Indians, who were instructed to render all the aid in their power in transporting the material, and locating the boring party at the place indicated by me for the first operation to commence.

The first defect observed by Mr. Cooper was that the outside and second-sized tubes were unprovided with the necessary screws for connection, and these consequently had all to be removed to the forge of Mr. H. Dougherty to be cut, involving an additional cost of 6*l*. 15*s*. on the engineer's account alone.* Moreover, some of the tubing in the hands of the engineer, being still in an unfinished state when Mr. Cooper left St. John's, remained at the forge till the 4th of July, when it was embarked on board the steamer *Plover* by myself.

In consequence of the very great difficulty which was experienced in dragging all the heavy material across the portage over the junction rapids of the Humber to Grand Pond, it was not until the middle of July that the machinery was in position to commence the first operation; which, however, proceeded rapidly afterwards, until it was discovered on extending the tubing that the outside

* This sum was in addition to a previous account paid to H. Dougherty of 30*l*. 12*s*. 8*d*. currency, by Mr. Cooper, making in all 37*l*. 7*s*. 8*d*. currency for engineer's work which ought not to have been required.—A. M.

tubes being too thin for flush joint screws, they gave way; while the third or inside tube was fitted with couplings outside, too large to go through the second size. These defects occasioned a further direct loss of rather over a week at bore A, where the work hitherto had been proceeding most favourably, having bored without serious interruption to the depth of 78 feet. Mr. Cooper then had to improvise a plan for forcing down the first set of tubes by attached weight, and to construct many articles on the spot which ought to have been perfectly supplied; among which were two lie-keys, two clevises to be altered, and a brace-head for the mounting, the one supplied being worthless. Further, Mr. Cooper states that in the invoice from Messrs. McClellan there is a charge as follows, to which he objects, viz.:—

	£	s.	d.
To 1 bell-screw, 2 feet long, to grip 2 inch at mouth and 1 inch at the bottom, all with 1-inch screw	2	5	0

Instead of which he says he found one screw 4 inches long, not good.

It will be seen by reference to the annexed columns that the first bore-hole, which is situated near the left bank of the river about a quarter of a mile above its junction with the Grand Pond, called bore A, was sunk to the depth of 250·8 feet; while the second, called bore B, is about 1¾ miles from the outlet, in a straight course north-east by north (true), on the right bank of the river. At the latter bore the total depth reached was only a little over 7 fathoms, Mr. Cooper, after several trials, having failed to get the tubes through, which invariably gave way at the joints. Here the work was much interrupted by erratic boulders, from which bore A was completely free.

Vertical columns accompany this Report, drawn to a scale of 7 feet to 1 inch, on which the various strata are represented by colours with the thickness of each given opposite, as also the depths sunk by the boring rod from the surface.

No.	Formation.	Bore A.	Thickness of Drift.	Depth of Bore.
			ft. in.	ms. ft. in.
1	Superficial or Drift	Soft sand	2 0	
2	„	Hard sand	0 9	
3	„	Brown coarse sand	27 0	
4	„	Loose gravel	3 0	

No.	Formation.	Bore A.	Thickness of Drift.		Depth of Bore.		
			ft.	in.	fms.	ft.	in.
5	Superficial or Drift	Soft sand	2	0			
6	"	Sand and mud	6	0			
7	"	Sandy clay and boulders	10	0			
8	Carboniferous	White sandstone	3	9	8	2	9
9	"	Ditto with argillaceous beds	2	6			
10	"	A greenish arenaceous clay, with bands of micaceous sandstone	16	0	12	1	0
11	"	Grey, finely laminated sandstone	4	0			
12	"	Dark brown shale	0	3			
13	"	Coal—free	1	4	13	0	7
14	"	Fireclay with fossils	0	9			
15	"	Argillaceous sandstone	2	5			
16	"	Dark brown shale	2	0			
17	"	Coal—foul	0	5			
18	"	Dark or blackish shale	5	3	14	4	10
19	"	White sandstone	3	6	15	2	4
20	"	Grey fireclay and shale	2	9			
21	"	Sandy shale	3	0	16	2	1
22	"	Argillaceous sandstone	8	6	17	4	7
23	"	Fireclay and bands of sandstone	2	0	18	0	7
24	"	Brown and mottled clay and shale	16	0	20	4	7
25	"	Bluish-white sandstone	15	0	23	1	7
26	"	Dark grey arenaceous shale	17	0	26	0	7
27	"	Dark brown shale	1	0			
28	"	Thin layers of coal in blackish shale	1	9			
29	"	Coal—foul	0	4			
30	"	Fireclay with fossils	1	8	26	5	4
31	"	Argillaceous sandstone	2	10	27	2	2
32	"	Thin-bedded sandstone	2	9			
33	"	Grey shale	2	6	28	1	5
34	"	Fireclay with fine streaks of coal	1	9			
35	"	Brown mottled arenaceous shale	4	6	29	1	8
36	"	Argillaceous sandstone	1	9			
37	"	Brown arenaceous shale	3	0	30	0	5
38	"	Sandy fireclay	5	9	31	0	2
39	"	Argillaceous sandstone	7	0	32	1	2
40	"	Greenish fireclay	2	4			
41	"	Brown ditto	3	0	33	0	6
42	"	Arenaceous and micaceous shale	9	0	34	3	6
43	"	White sandstone	5	10	35	3	4
44	"	An argillaceous bed	0	5			
45	"	Grey sandstone	2	6	36	0	3
46	"	Argillaceous sandstone	2	9			
47	"	Arenaceous shale	2	6			
48	"	Coal—free	0	2			
49	"	Grey fireclay	1	9	37	1	5
50	"	Argillaceous sandstone	3	6			
51	"	Grey shale with coal plants (Sigillaria ?)	4	6	38	3	5
52	"	Fireclay with thin streaks of coal	3	9	39	1	2
53	"	Red and brown mottled shale	4	0			
54	"	Hard compact sandstone	0	6			
55	"	Grey shale	2	6	40	2	2
56	"	Red shale	4	0	41	0	2
57	"	Brown mottled shale	4	6	41	4	8
		Total thickness of strata and depth of bore ..	20[illegible]	6	250	8	0

No.	Formation.	Bore B.	Depth of Bore.		
			fms.	ft.	in.
1	Superficial	Coarse sand	0	5	0
2	"	Sand—finer than No. 1	2	5	0
3	"	Rough gravel	0	2	9
4	"	Soft sand	0	5	6
5	"	Very hard boulders	1	5	0
6	"	Sandy clay..	0	1	9
		Total depth of Bore B	7	1	0
			or 43 feet		

The bore A was abandoned on the 15th of September, and the party removed with the apparatus to the position indicated as bore B, on the same day. Here the operation was entirely unsuccessful, partly in consequence of the nature of the superficial material, which was encumbered with numerous erratic boulders, but principally from the very defective state of the tubing, which constantly gave way at the joints. The column will show that the greatest depth attained was still in the superficial deposits, and it remains uncertain how much farther the bore may require to penetrate before striking the solid strata. After several attempts to get down to the rock in vain, Mr. Cooper was obliged to abandon the work, and store away the machinery for the winter, as the working season was fast drawing to a close, and the party were required to be at the Bay of Islands in time to return to St. John's by the steamer *Curlew* about the 4th of November. The party arrived here on the 8th November, and was paid off as soon as possible afterwards.

A storehouse having been erected in the locality of bore A, the whole of the apparatus was deposited therein, and secured for safety during the winter. The following is a list of the items as certified by Mr. Cooper:—

19 pieces of 9-feet rods, 1¼ inch—one cut for forging; 10 pieces of 9-feet rods, 1⅛ inch; 20 pieces of 9-feet rods, 1 inch; 10 pieces of 6-feet rods, 1 inch—two cut; 5 pieces of 5-feet rods, 1 inch—two used for forging; 6 pieces of 4-feet rods, 1 inch—for ends; 3 pieces of 2-feet rods, 1 inch—one used; 3 pieces of 1-foot rods, 1 inch—for hook; 1 piece of 9 inches; 1 pump, 3¾ inches diameter; 1 pump, 3 inches diameter; 1 pump, 2 inches diameter; 1 pump, 1½ inch diameter; 2 dozen chisels; 1 wire rope with fittings; 1 crane; 2 ⅜-inch chains, 45 feet; 6 hand-keys, 2 lie-keys, 2 brace-heads; 1 iron boring brace; 1 anvil; 2 hand hammers; 1 sledge hammer; 1 9-lb. metal mallet; 1 forge; 1 vice; 2 specimen cutters; 2 X chisels, 2½-inch; 1 X chisel, 3½-inch, broken; 1 X

chisel, 4½-inch; 1 lever fulcrum and rests; 2 hooks for metal pulleys for ropes and chain; 6 cat's paws for rod lifting and lie-tubes for rod gripping; 2 rods, ⅝ iron round; 2 saws; 4 wood chisels; 2 spokeshaves; 1 1½-inch lifting screw; 60 feet of tube, 4½ inches inside; 105 feet of tube, 3½ inches inside; 5 sling chains; 3 sets of tube glands; 2 stag screws; 3 wood augers, 1½, ⅞, ⅝; 1 oil can; 2 oil feeders; a small square; 1 pick-axe; 2 shovels; 1 spade; 40 feet of 5-inch pump rope; 3 clasp links: 6 small shackles; 1 soldering pot; 1 spring weighing balance; 1 shifting screw wrench; 1 flattener; 1 hollow cup; 3 pairs of tongs; 2 sieves; 2 pails; tool chest.

Although the coal seams cut at bore A are clearly too thin to be of economic importance, the actual section given is so far satisfactory as being corroborative of the views expressed in my Report for 1865, a portion of which is repeated below; but it must always be borne in mind that the experiment has only tested the outcropping edges of the strata, and that the question of whether workable seams of coal exist or do not exist, remains still as doubtful as ever, and cannot possibly be answered with any degree of certainty until higher measures have been penetrated. The general dip of the strata, which is at a very low angle, being northerly, it will be clear that the accumulation will be proportionately increased with the distance in that direction, until they turn up again presenting a dip to the southward; and it appears to me now, as it has all along, that the centre of the trough thus formed is by far the most probable position for the existence of a workable seam of coal to be found. The rocks which hold that position would be found to belong to the same or nearly the same horizon, moreover, as the strata at Robinson's Brook and the middle Barachois of St. George's Bay, which contain some seams of coal of fair thickness; but there is no possibility of being assured of the presence of these seams, without further experiment.

It will be observed by the following quotation from my Report for 1865, that the views I entertained of the general structure then, were almost identical with these our more recent experiences, especially as regards the boring at A, have proved to be facts. The Report of 1865 alluded to, was printed by order of the Legislative Council, and a few copies only were distributed in the form of letters or circulars.

"In the valley of Coal Brook (of Grand Pond) the sandstones (i.e. of the Millstone Grit) are exposed in cliffs from 20 to 60 feet

high, where they are in some parts considerably tilted, more particularly near their junction with the greenstone of the Conical Hill, which probably is intrusive. To the northward of the Conical Hill the rock is mostly concealed, but the level character of the country seems to indicate the probability of there being little disturbance. Fossil plants, the bark of the stems of which are always converted into coal, abound in some of the sandstone beds on both sides of the lake, and at Coal Brook; and thin irregular seams and nests of coal were observed at several places. Mr. Jukes, in his work on the Geology of Newfoundland, mentions the occurrence of a seam of coal 6 inches thick on the Coal Brook; but this seam I did not see, its outcrop probably, in the interval since his visit, having been covered over by débris from above, which it is evident is constantly falling sometimes even in heavy landslips; bearing the trees and bushes in inextricable confusion along with them. Small fragments of coal occur on the bed of the brook, however, and are sparsely scattered among the gravel along the shores of the Grand Pond. There is clearly a seam of coal near the outlet of the main brook (i. e. river), part of the outcrop of which appears to lie between the mainland and the small island I have called Seal Island (from the number of seals which frequent its shores); as on every occasion when the lake has been agitated by strong westerly winds, quantities of small angular fragments of coal are washed up on the beach; but the great accumulation of sand and boulders, both on the main shore and on the island, together with the vegetation that surmounts it, effectually conceals the strata from view, where the outcropping edges might reasonably be expected. Judging from the fragments found, however, which in some cases appeared to produce the whole thickness of the seam, it is probably of but little importance; although by the process of boring through it, the facts might easily be ascertained. Similar small seams and nests of coal occur in the lower part of the same formation in Cape Breton, but there is, so far as is yet known, a vertical thickness of several hundreds of feet between the position of these and the lowest workable beds; so that reasoning on the analogy that exists between the circumstances in the one case and those in the other, and supposing the sandstones of Grand Pond to be the equivalents of those holding the same

general characteristics in Cape Breton, the inference will be that the workable measures will most probably occur at a higher geological horizon. From what I have been able to observe, if the workable beds of Cape Breton are represented at all in the central trough of Newfoundland, the country where they may be expected to be found will be in the region between the Humber River (west branch) and Sandy Pond, where there is ample room to bring in a sufficient accumulation of thickness; although the character of the country at that part is sorely against surface examination, it being in a great measure covered over by dense vegetation or marsh."

Accompanied by the Honourable W. S. Donnelly, Surveyor-General, I arrived at the Grand Pond on the 21st July, and the next day proceeded to the boring location, where we were greatly pleased to find the whole party in excellent health and spirits, while the operation was proceeding as rapidly and favourably as could be desired. While at the Grand Pond, Mr. Donnelly and I made the circuit of the lake passing round the great island, but our time for a satisfactory re-examination of the geology was too limited, as it had been previously arranged that we should cross over to Notre Dame Bay by the middle of August, in order to settle sundry disputes between parties holding mining licences there. In the meantime Mr. Howley was instructed to make a survey of the upper waters of the west branch of the Humber River, beginning at the falls of that river, where my survey of 1866 terminated, and to investigate by surface examination the structural details, especially of the Carboniferous rocks, as far as possible. Mr. Howley was also instructed to test the altitude of the Grand Pond instrumentally above the water level at the foot of the Junction Rapids, as it became obvious that the rough estimate which I made of the fall in 1865 was considerably under the reality, and the result obtained by our aneroids was unsatisfactory. On our return from the excursion round the lake, we rejoined Mr. Cooper's party at the boring, when we found the work had been interrupted by the insufficiency of the tubing, which had not got down to the seam of coal (No. 17 of the column Bore A) already struck by the borer, and being very anxious to ascertain the actual value of this seam, we remained on the spot until the

borer had passed through to the strata below. We afterwards crossed over the country by the course of the eastern branch of the Humber, through Sandy and Birchy Ponds, crossed the water-shed thence to the Indian Brook (River), and descended the latter to Hall's Bay, where we arrived on the 16th of August. We were conveyed from Hall's Bay to Betts Cove and Little Bay mines on board the steamer *Hiram Perry*, through the kindness of Mr. Ellershausen, who at that time was making a round of the various localities in which he had interest. At the latter place I engaged three men to assist me in making a survey through the interior between Little Bay and the Naked Man in the south-west arm of Green Bay, connecting also with the western arm. The purpose of this survey was essentially to determine the correct geographical position of the boundaries of various mining licence locations, which, in consequence of the inaccuracies of the map upon which they were originally laid down, together with the vague and incoherent manner in which they were described, could not be identified to the satisfaction of either of the neighbouring locatees. The survey was commenced at the head of Western Arm, where, having established a true meridian, a connection was made with the points previously fixed by Captain Maxwell, R.N., and a measurement carried forward up the brook which falls in there; but while thus engaged I became completely prostrated by a very severe illness, and was compelled to return as best I could to Little Bay mine, where I communicated by telegraph with Mr. Howley, who at the time was within reach of Sandy Point station, to discontinue the re-examination of Grand Pond, and to proceed as soon as possible to Little Bay mine to finish the work which I had begun.

Since his return to St. John's, Mr. Howley has plotted his survey of the west branch of the Humber on a scale of 1 inch to 1 statute mile, with which is connected his survey across the portage over the Junction Rapids, the northern end of the Grand Pond, and the lower reaches of the eastern main river up to the position of the bore-holes. The result of his observations across the Junction Rapids portage, shows a difference of level from the still water at the foot of the rapids to Grand Pond normal surface of 96 feet; which, supposing the fall below to be 20 feet to the Bay of Islands, would place the Grand Pond level 116 feet above

the sea instead of 50 feet as represented in the original map, and the upper waters also of the Eastern Humber correspondingly at a higher altitude.

The mining location survey between Little Bay, south-west arm of Green Bay and connecting with Western Arm, Mr. Howley has protracted and mapped topographically on a scale of 4 inches to 1 mile, a tracing from which has been furnished to the Surveyor-General's office.

Survey of West Branch of the Humber River.

In my Report for 1866 (dated 1st March, 1867), a description of the west branch of the Humber River will be found up to the falls where Mr. Howley's measurement commenced. The general courses upwards above the falls are as follow:—

No.	Courses from True Meridian.	Miles.	Positions and Remarks.
1	N. 24° E.	9½	From falls to the centre of Birchy Pond.
2	N. 22° W.	3	From centre of Birchy Pond to outlet at Aldery Pond.
3	West.	1	Along an expanse, with slight current and many islands.
4	S. 33° W.	7	Still water and generally straight, making a sharp turn.
5	Northerly.	1½	Rapids and swift water to a turn westerly.
6	S. 47° W.	2¼	Sharp turns and rapids to the outlet of Adie's Pond.
7	S. 47° W.	4½	Along Adie's Pond to the south-west end.

Aldery Pond (course 2) is the lower expansion of a tributary stream proceeding from the northward, of considerable size, but which becomes very rapid and turbulent at a short distance above the pond. It takes its rise among the Laurentian mountains to the northward and westward. Several minor tributaries flow into the main river, the larger of which join respectively at the north-eastern angle of Adie's Pond, and 2 miles below the same pond, both proceeding from the hills to the northward.

Adie's Pond is rudely in the form of a parallelogram, with the longer sides slightly bent inwards towards the middle. The total length from end to end is 4½ miles, the width at each end ranges from 1¾ to 2 miles, while at the central part it is contracted to less than 1½ mile. The sources of the main stream take their origin far to the northward amongst the Laurentian mountains, which form the watershed between the Humber Valley and Bonne Bay, and thence flow, first southerly and finally easterly, dis-

charging into Adie's Pond, near the middle part of the north-west side.

In my Report for 1866, the river above the junction of the east and west branches is described as being rapid, with the exception of a few small expansions of still water, all the way to the falls; and Mr. Howley states that the same character prevails for about 3 miles upwards from the falls, but above that part it flows with a gentle current and smooth water from Birchy Pond, which, with the stream above and Aldery Pond, are nearly on a level. A portage of about 12 miles across the country, from the north-east angle of Birchy Pond, leads to the head of White Bay; that point being at the commencement of the great ox-bow bend of the river, and the nearest to the sea on the eastern side of the island. From the outlet of Aldery Pond upwards, long reaches of still water alternate with short rapids, the general course pointing straight or nearly so for Adie's Pond. The latter is a fine expanse of water, having a surface area of over 6 square miles, lying at the eastern foot of the Long Range mountains. A portage bearing S. 32° E., 6 miles to Sandy Pond, leaves the river about 4 miles above the falls. Mr. Howley represents the country on both sides of the valley as being generally flat or gently undulating, partly wooded, but with many extensive areas of marsh. There are, however, intervals of good land upon the banks of the stream and its numerous islands, and at many parts, especially around Adie's Pond, good-sized pine trees are abundantly sprinkled through the forest. From Adie's Pond to Aldery Pond this level tract is bounded on the north-west side by the mountains, which rise abruptly at a short distance from the lakes and the connecting stream.

Although the topography of this part of the country as represented on the original map (which was altogether sketched in from description given by the Indians) requires considerable modification, it will be perceived that in the general features it pretty closely resembles the results found by actual survey, and that the character of the surface, as described by Mr. Howley, in most respects corresponds with that given in my Report. The position of Adie's Pond bears from the junction of the branches N. 26° E., 11½ miles, and is distant from the head of the east arm of Bonne Bay about 23 miles, taken in straight lines.

Geological Structure.

The whole of the valley surveyed from Adie's Pond downwards intersects members of the Carboniferous series, and the lower outcrops of that series correspond with the boundaries of the great level tract where it terminates against the mountains; in this respect, also, verifying the general accuracy of the lines represented in the original map. The facts ascertained, however, by Mr. Howley, taken in connection with my own observation in 1865, reveal the existence of a series of folds and sharp flexures which affect the distribution of the different members of the group, and show that the volume of the whole mass is considerably less than that displayed in St. George's Bay, the lower measures of which appear to be nearly or (at some parts) altogether absent. The succession according to the evidences at the sundry outcrops, which however are often remotely apart, the greater part of the area being concealed by superficial deposits, dense vegetation, or water, appear to be as follows up to the horizon of the stratum of coal No. 17, Bore A:—

Succession of Carboniferous Strata—Central Trough, Newfoundland.

Ascending Order.

	Feet.
1. Coarse reddish conglomerate and red sandstone, with occasional bands and divisions of red marl or shale	800 (?)
2. Greenish and dark grey calcareous and arenaceous shales, with irregular beds of sandstone and nodular calcareous layers interstratified; some fossil plants, mostly obscure, were found in the shales, amongst which were the bark of a *Lepidodendron* (?) and some reeds or calamites. The bark converted into coal say	600
3. Coarse red conglomerate in thick beds, passing upwards into red sandstone	530
4. Reddish and brownish micaceous sandstone, with beds of fine conglomerate with numerous pebbles of white quartz, interstratified with bright red argillaceous shale, which is frequently mottled and patched with green spots	1050
5. Whitish or pale grey very micaceous sandstones, mostly fine grained, overlaid by arenaceous and argillaceous shales, the former usually very micaceous, the latter red, brown, or mottled with green, and rather coarser micaceous grey sand-	

	Feet.
stones. Among these latter strata numerous thin seams and nests of coal occur, with fireclays, sometimes without coal, while at the top a seam of coal with fireclay below and a similar clay above, 1 foot 6 inches thick, occurs, struck through by the boring rod	300
6. The strata in the centre of the trough is completely concealed below a great accumulation of drift (see account of the bore-holes), but judging from the rate of dip ascertained where the strata is exposed, and the position of the coal seam, No. 17, A Bore, and taking into consideration the undulations of the formation, there appears to be room for an accumulation of strata above the coal seam, No. 17, A Bore, of not less than	800
Total	3280

The thickness given in the above section must be considered as only approximate, as in no case over the whole region is there a continuous exposure of a succession in regular sequence beyond a short distance, and such only include portions of one of the divisions of the group. The lower measures, however, upon the western side of the trough are but slightly disturbed, and the average thickness can be fairly estimated by the breadth of country they appear to occupy; but upon the eastern side, on both sides of the Grand Pond, there is much disturbance and many repetitions of strata which finally butt up against a great fault running along, or near to, the south-western shore of the lake, north-east and south-west at the base of the mountains. The lower division, No. 1 of the section, observed at Adie's Pond, strikes thence about south-west, and is recognised at the lower end of Deer Pond on the north-west shore, in both cases in nearly a horizontal attitude, resting against the gneiss of the Laurentian mountains; while at the upper end of the same pond on the south-east side, the conglomerate is turned up vertically, whence it strikes into the vast marshes which extend across to the northern end of the Grand Pond. The conglomerate is again recognised at the northern end of the great island, where it dips about N.N.E. $< 20°$, and succeeding it above is the representative of division No. 2, being a succession of shales and calcareous rocks with obscure fossil remains. At the base of No. 2 there are some alternating beds of red and green sandstone, with red shale and beds of limestone or dolomite. On the eastern shore of the lake, nearly

opposite the northern end of the island, a section of strata was measured in 1865 as follows, the dip being N. 6° E. < 30°:—

DESCRIPTION OF STRATA, ASCENDING.

		Feet.
1.	Yellow-weathering beds of limestone or dolomite	20
2.	Red shale with layers of round yellow nodules	20
3.	Black shale	12
4.	Red shale	30
5.	Greenish-grey coarse sandstone	20
	Concealed for 60 paces.	
6.	Red shale	20
7.	A bed of dolomite	1
8.	Red and brownish shale	45
	Concealed for 160 paces.	
9.	Red shale with bands of yellow-weathering nodules	10
10.	Green slaty shales with thin bands of dolomite (?)	3
11.	Thin-bedded yellow-weathering, containing a red mineral, probably *talc* (?)	3
12.	Black shale	5
13.	Red shale with many yellow nodules and nodular layers, three beds of the latter at top	12
14.	Chiefly greenish, thin, hard beds, with yellow nodules at the base, thin flaggy beds at the top	30
15.	A set of compact, hard, red beds interstratified with shaly nodular strata	12
16.	Greenish compact and hard beds in thin layers	20
17.	Green and blackish shale	15
18.	Thin-bedded yellow-weathering limestone or dolomite	24
19.	Red, fine-grained sandstone and reddish shale to the top of the cliff	30
	To which may be added for concealed ground	100
	Total	432

The strata of division 2 are described in my Report for 1866 as forming a flat anticlinal between John's Fall and the fall where Mr. Howley's survey began, thus:—"At John's Fall the banks, which are sometimes upwards of 30 feet high, exhibit black and greenish calcareous and argillaceous shales, interstratified with beds of dark grey nodular limestone, varying in thickness from 1 to 7 inches, in nearly horizontal strata, which continue to be exposed up the long reach at the great bend and on either side of the river to the foot of the upper fall, where they again dip below the coarse conglomerate, inclining at a moderate angle up the river to the north-eastward, showing a flat anticlinal between the two falls."

The conglomerate alluded to above is the lower stratum of division No. 3, above which in the interval between the east and west branches of the Humber the rocks are entirely concealed.

In my Report for 1866, and in the original map, a great fault is represented, intersecting the island diagonally, the course of which passes a little east from the bed of the west branch of the river, running in the direction of White Bay. The evidences of this fault are very distinctly displayed at the head of White Bay, at the north-east end of Deer Pond, on the Spruce Brook of the Grand Pond, and near the foot of the Long Range mountains in St. George's Bay; but the nature of the country between the branches of the Humber is such as to prevent the possibility of tracing it there; and the usual flat character of the land, together with the apparently undisturbed state of the strata wherever seen, lead to the inference that probably the dislocation, while contemporaneous with the lower measures, is older than No. 4, and that it, in common with the lower strata, is covered over by the higher measures unconformably.

The fault on the east side of the Grand Pond, on the other hand, is well pronounced for a great part of the whole length of the lake, where the various members of the Carboniferous series butt up in highly disturbed strata against a mass of greenstone which follows a very straight course along the western flank of the gneissoid mountains, pointing in the direction of the inlet into Sandy Pond.

The lower strata of No. 5 are to be seen in a very disturbed state on the western side of this fault at Coal Brook, being tilted up at a high angle and dipping in different directions, but towards the north-west they become nearly flat; and, judging from the results of the boring experiment, together with the flat character of the land beyond in that direction, maintain only a small angle of 3° to 4° from the horizontal, dipping towards the central country between the two rivers. Among the strata on Coal Brook, Mr. Howley saw a seam of coal about a foot thick, which possibly may be the outcrop of the seam No. 17, Bore A, although I am still of opinion that it is at a lower horizon, and that the highest seams struck with the boring rod will outcrop, as stated before, between the outlet of the river and Seal Island, striking to the eastward along the shore of the lake.

About a mile up Coal Brook from the outlet at the lake, and about 100 yards from the greenstone and fault, Mr. Howley found strata of micaceous sandstone and shale dipping S. 65° E. < 10°, which turns over a little higher up the stream, and dips at a very high angle in the opposite direction, succeeding which are the following beds, given in ascending order, on a dip N. 70° W. < 78°:—

	Ft.	In.
1. Greenish-grey micaceous sandstone at the base.		
2. Fireclay	1	5
3. Coal—free	0	3
4. Coal—foul, soft, and shaly	0	11
5. Fireclay	0	2
6. Grey micaceous sandstone	1	0
7. Fireclay	0	6
8. Coal—free	0	9
9. Coal—foul, soft, and shaly	0	2
10. Fireclay	0	7
11. Whitish micaceous sandstones at top	2	0
Total	7	9

In my Report on St. George's Bay region for 1873, at page 310, a general section of the Carboniferous group of Newfoundland will be found, in which the upper division (*e*) of green and red sandstones, with shales, clays, fossil plants, &c., I take to be the equivalent of No. 5 of the section now being considered, while the reddish and brown sandstones of division *d* are equivalent to the upper part of No. 4. The thickness given of division *e* is 1000 feet; and there is ample room in the central part of the trough of Grand Pond to bring in an accumulation of equal volume, although I have put it down as a minimum of 800 feet. As it is in this division of the group that the coal seams of apparently economic importance occur in St. George's Bay, I still consider it very probable that such or similar seams may exist about the same horizon in the central trough; but it is utterly impossible, in consequence of the nature of the ground, to ascertain with any certainty whether such exist or not without further actual experiment. I consider, therefore, that the boring process should be continued until the ground is thoroughly tested.

It is true that under any circumstances the area of the coal-bearing strata must be very circumscribed; but supposing it to be

limited to about 7 square miles, and, further, supposing that a sheet or stratum of coal 3 feet thick was spread over an area of 6 square miles, the value of such a seam may be estimated as follows:—

A seam 3 feet thick would yield at the rate of 4740 tons to 1 square acre.

A seam 3 feet thick would yield at the rate of 3,023,600 tons to 1 square mile.

A seam 3 feet thick would yield at the rate of 18,141,600 tons to 6 square miles.

It will be obvious that the existence of such a seam of coal (without taking into account the probability of other seams occurring), or even one of smaller extent, while insufficient to establish a permanent coal industry, would be of vast local importance for many years to come.

While considering the desirability of having the Carboniferous regions thoroughly tested, so as to arrive at a satisfactory conclusion as to the extent or volume of workable seams of coal, I think it well to reiterate what I have expressed in former Reports, that the only means by which such knowledge can be obtained is by carrying out a regular system of boring over all the areas where the higher strata of the group are known to be spread. The condition of the country around St. George's Bay is but little more favourable for surface examination than is that of the central trough, and it is over the areas occupied by the higher measures in both instances that the rock is nearly everywhere concealed by drift, forest, and marsh; hence, although coal seams of workable thickness may be actually known to exist by one or two accidental outcrops, the area they occupy, or the amount of fuel they are capable of yielding, no one can possibly make the rudest approximation to a calculation of without the test of the boring rod being repeatedly applied.

In our Report for 1873 it is stated that the outcrop of a coal seam was observed at Robinson's Brook, which appeared to be about 4 feet thick, and of undoubtedly excellent quality. Now it certainly must be obvious that to ascertain the actual distribution of such a seam is a matter of paramount importance, and one without which no one would be justified in making an attempt at practical mining, because the results to be derived from such an

operation, even supposing the thickness to be constant, would greatly depend upon the extent of area it occupied. Based upon the same calculation as before in estimating the value of a coal seam, if this 4-feet seam was found to extend over 1 square mile, it would be capable of yielding 4,044,300 tons of coal, and proportionally more or less according to the ground it is spread over; moreover, by using the boring rod, other seams might be revealed, the outcrops of which would in all probability never otherwise be discovered.

Plan for Settlement on South-west Arm of Green Bay Road and Indian Brook, Hall's Bay.

By desire of the Premier, I have constructed a map embracing the country between the new line of road from South-west Arm of Green Bay and the valley of the Indian Brook, Hall's Bay, upon a scale of 1 inch to 1 mile. The line of road is reduced from Mr. Charles Harvey's original survey; the course of the Indian Brook is from my own survey of 1865; while South-west Arm and Hall's Bay are from surveys recently made by Mr. Howley and myself. It was satisfactory to find that the point of intersection at the crossing of Indian Brook of the two respective and altogether independent surveys, although started from points remotely apart from each other, exactly corresponded; and that the latitude of the same point was within one second of that established in 1865.

On the map will be seen the system I wish to recommend for the settlement of the land, the principle of which may require some explanation.

The primary base for blocking off the land is a true meridional line drawn through King's Point in South-west Arm, which in its southern extension crosses the Indian Brook at a well-marked turn of the river, about 3 miles above the falls. Upon this line square blocks are raised on the east and on the west sides, each containing an area of 36 square miles, or 24,040 square acres. These primary blocks are subdivided into single square miles, to be distinguished as concessions and ranges; the dividing lines of the former being arranged by numbers, 1, 2, 3, &c., and running due east and west; while the dividing lines of the latter are represented by letters A, B, C, &c., and running due north and south. The ranges will be

further particularised as east or west, as relating to the meridian of King's Point.

The single mile block range A west, concession 3, and a part of concession 4, being situated round the harbour of King's Cove, is subdivided into four parts designated on the plan as (*a*) (*b*) (*c*) and (*d*); the first of which, viz. (*a*) is a strip of about 4 chains wide surrounding the harbour, which I propose to be held in reserve for public purposes; the remaining three lots, which will contain an area of about 150 acres each, to be sold as agricultural lots.

All range and concession dividing lines to be reserved for a width of at least 1 chain, or 66 feet, for local roads, which process will reduce the mile area to 624 acres. This will give four lots of 151 acres each, which are represented on the plan by north and south parallel lines, and numbered from No. 1 to No. 48 west ranges, and from No. 1 to No. 24 east ranges. The blocks where the lot lines are drawn out upon the map show the position of such portions of country as appear to be best suited for early settlement; of which altogether there appears to be an area of about 60 square miles, or say 38,400 acres.

That a very large proportion of this extensive area is capable of reclamation, and if properly cultivated, made to yield almost every kind of agricultural produce, appears to me to be beyond doubt; and nothing is more likely to be conducive to the general improvement and eventual prosperity of the country and the welfare of its people than permanent settlement on the land; but there are difficulties in the way of that most desirable result, which must be overcome before advance in that direction can possibly take place. First of all, in order to be in a position to dispose of Crown lands like other colonies, complete revision or re-modelling of the existing land laws is imperatively required; and, in particular, the present system of granting so-called *mining* licences of search over 3 square miles of country with exclusive privileges over the whole area, must be abolished. As the law now stands, the whole face of the country may be spread over with those mining licences, upon which agriculture is virtually prohibited, settlement obstructed, and general improvement rendered impossible; all for the very questionable probability of some small spot upon the surface, supposed to exhibit indications of mineral substances, ultimately developing into a mine. A time ought to

be specified by day and date, when all such licences or grants of land shall finally terminate; and all future concessions of either licences or grants of land shall be determined by the position they occupy upon the map, which will be laid off in blocks of, as nearly as possible, a square mile each, and approved of by the Surveyor-General.

I have the honour to be, Sir,

Your most obedient servant,

ALEXANDER MURRAY,
Director of Geological Survey.

To the Hon. W. J. S. Donnelly,
Surveyor-General, St. John's.

CHAPTER XX.

SPECIAL REPORT UPON THE DISCOVERY OF GOLD NEAR BRIGUS, CONCEPTION BAY, DATED OCTOBER 8TH, 1880.

ST. JOHN'S, NEWFOUNDLAND,
October 8th, 1880.

MAY IT PLEASE YOUR EXCELLENCY,

Reports having been circulated for some time past that gold had been discovered in quartz veins in the regions near Brigus of Conception Bay, I considered it my duty to make a personal examination of the ground, and to have portions of the veins tested by blasting, under my own immediate supervision.

These rumours of the presence of the precious metal have naturally had the effect of inducing people to make applications at the Surveyor-General's office for licences of search over the supposed auriferous area, amongst whom, Mr. J. W. Foran, of this place, was one, who displayed to me some beautiful small specimens of native gold, and kindly engaged to guide me to the spot where it was found.*

Accordingly, in company with Mr. Foran, I proceeded to Brigus on Monday, 27th of September, and on the afternoon of the same day visited the locality upon which he holds his claim. Here I selected and marked out a series of spots upon the quartz for trial; and on the following day, which proved a rainy one and unfit for experimenting, I inspected another area about 2 miles south-west from the former place, and nearly in the strike of the quartz-bearing strata, where I found the rocks with their reticulations of quartz veins to be nearly identical in all respects. This latter place is known locally as Fox Hill, and from it sundry specimens

* In my Report for 1868, p. 167, I endeavoured to draw attention to the quartz veins at sundry places in the peninsula of Avalon, from the resemblance I perceived in the rocks they intersect to the recognised auriferous strata of Nova Scotia, but it is only within the last twelve months that any attempts have been made to prove the ground.—A. M.

of gold are said to have been taken, one of which is in my possession. It was not till Wednesday, the 29th, that we were able to reach the spots I had first indicated for experiment, and then it was with no small difficulty that we found our way through the dense fog which prevailed. The place where I finally determined to try the first blast is situated near the so-called Brigus Look-out, about equidistant from two peaks, each a triangulation-point of the Admiralty Surveyors, the height above the sea being marked on the chart respectively 408 and 413 feet.

By the first blast from 2 to 3 cubic feet of rock was removed, all of which was carefully broken up, washed, and examined; which operation finally resulted in the display of ten or twelve distinct "sights" of gold. In one fragment about 5 lbs. weight, largely charged with dark green chlorite, the gold shows itself in three places distinctly, while many small specks are perceptible by means of a good lens. The fracture of a fragment of milky white and translucent quartz, which was broken off the large piece, revealed two patches of gold, both of which together, if removed from the matrix, would probably produce about 1 dwt. (pennyweight) of the metal; whilst several small masses or nuggets were found adhering to the small broken fragments of quartz at the bottom of the pail in which the rock was washed, the largest of which contained about 10 or 12 grains of gold. From some specimens in which no gold was perceptible to the naked eye, and which I had selected for analysis, I found amongst the dust at the bottom of the bag in which it was carried a small nugget weighing 3 grains. A second shot was tried on the same lead at a few yards distant from the first, but owing to our imperfect implements, it failed to blow out more than a few pounds of rock in which no gold was perceptible. In the specimen I procured from Fox Hill, the metal occurs thickly in the minutest specks, scarcely if at all perceptible to the naked eye, but readily recognised under the lens, where it chiefly surrounds a small patch of chlorite.

The rock formation intersected by these auriferous quartz veins is of Huronian or Intermediate age, belonging to Division C of Report for 1868, or the group of strata next below the *Aspidella* slates of St. John's. The group consists chiefly of greenish fine-grained felsite slates, which, judging by the weathering of the

exposed surfaces, are also magnesian and ferruginous. The cleavage is exactly coincident with the bedding, and the slates occasionally split into very fine laminæ, but frequently into strong stout slabs, which are used to a considerable extent at Brigus for paving, for hearth-stones, and for building foundations and walls. A dip taken on the beds just in front of the place where the gold was found was N. 56° W. by compass, or N. 88° W. from the true meridian, < of inclination 45°. Parallel joints intersect the strata bearing S. 80° W. magnetic, or S. 48° W. true. By the side of the road at Brigus, the dip on some strong slabby beds was found to be N. 42° W. magnetic, or N. 74° W. true, < of inclination 40°.

A rough and hummocky belt of country from $\frac{3}{4}$ to 1 mile wide, which forms the nucleus of the peninsula between Bay-de-Grave and Brigus Harbour, is thickly intersected by reticulating quartz veins, varying in thickness from less than an inch to upwards of a foot, which often appear to ramify from a central boss or great mass of quartz, often extending over many square yards, and usually forming low, isolated hummocks or hills. The general run of the belt is as nearly as possible north-east and south-west from the true meridian, having been traced in a south-west direction from Brigus Look-out as far as Fox Hill, and, as I am informed, can be traced for several miles more in the same direction. Thus, although many of the veins, both small and large, may be seen for considerable distances to run exactly parallel with the bedding, the network of the whole mass runs obliquely to the strike of the beds, which are also minutely intersected by the smaller veins crossing and reticulating in all directions. I nowhere observed anything to indicate a *true fissure vein*, and consider these with gold as altogether *veins of segregation.*

The resemblance in general character of the strata with their included auriferous quartz veins in Newfoundland to those of Nova Scotia, must strike any one who has visited the two countries with the purpose of studying their geological features; and I venture to say that the description given of the latter country by Dr. J. W. Dawson might, in many respects, equally apply to the former; although, according to that author, the auriferous country of Nova Scotia is supposed to be of Lower Silurian age; while that of Newfoundland is undoubtedly unconformably below the Primordial

group, which, with abundant characteristic fossils, skirts the shores of Conception Bay. Without presuming to offer an opinion as regards the age of the Nova Scotian strata, the fact of the resemblances is suggestive.

Chlorite is profusely disseminated through the quartz veins, filling up cracks and drusy cavities; and it was observed that the visible gold was always in or near a patch of chlorite. Some specimens which were procured at the place of trial presented small cubes of galena, minute cubical iron pyrites, and, in a few instances, small crystals of sulphate of copper, together with specks or grains of gold.

That a large area of country in the regions referred to is auriferous there can scarcely be a doubt, although nothing short of actual mining and practical experience can possibly prove what the value of the produce may be, or whether the prospects of obtaining a remunerative return for the necessary outlay are favourable or otherwise. The specimens which have been obtained, although an unquestionable evidence of the presence of the precious metal, cannot by any means be taken as indicative of a certain average yield; indeed, to quote the words of Dr. Dawson, from his 'Acadian Geology,' p. 626, where he says: "It is not easy from mere inspection of the vein-stone to predicate as to its value, since the gold is *usually invisible* to the eye;" and again, at the following page, when treating of the characteristics of the Waverly Mine, he says, "*visible* gold is rare in this vein at present, the greater part being in a minutely disseminated and *invisible* state." An analysis of quartz collected, in which gold is imperceptible to the naked eye, may aid in revealing some evidence of its constancy, and may throw some light upon the possible average of superficial contents over certain areas under similar circumstances; but it may safely be predicted that the irregularities of distribution, so conspicuously displayed by the veins on the surface, will extend beneath it, and that it will be mainly on the stronger and more persistent bands, where intercalated with the strata, that mining will extend to any considerable depth.

The indications of gold in this country, then, are certainly sufficiently favourable to merit a fair trial; and there are good reasons to hope and expect that ample capital applied to skilled

and judicious labour may be found remunerative to future adventurers, while a new industry will be added to give employment to the labouring population of the island, and possibly bring this despised and but little known colony into more prominence and consideration abroad than it hitherto has enjoyed.

I have the honour to be,

Your Excellency's most obedient servant,

ALEXANDER MURRAY.

His Excellency
Sir John H. Glover, G.C.M.G.,
Governor of Newfoundland, &c. &c. &c.,
St. John's.

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